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THE HUDSON RIVER TUNNEL was sold under foreclosure proceedings on June 16 and 17, and was bid in by Stetson, Jennings & Russell, counsel for the tunnel bondholders, for $400,000, subject to a lien of $62,000 by S. Pearson & Son, of London, the contractors who did the last work on the tunnel. The work actually completed consists of the sinking of shafts near the river bank on each side, and the building of 3,915 ft. of one tunnel from the New Jersey side and 145 ft. of tunnel from the New York side. Besides this about 550 ft. of the second tunnel was built eastward from the New Jersey end in the early history of the enterprise. Nothing has been done on the approaches, which, as originally planned, would be about 4,000 ft. long on the New Jersey side and about 4,500 ft. long on the New York side; and about 1,600 ft. more must be built to complete the river section of one tunnel. The main work on the tunnel was done from 1879 to 1882, and in 1890 some additional work was done with English capital, English engineers and contractors being in charge.

ANOTHER CAPE COD CANAL SCHEME is reported as well under way, it being stated that the recently chartered Boston, Cape Cod & New York Canal Co. has sold $6,000,000 of bonds "to a New York syndicate." The canal will be 300 ft. wide, 25 ft. deep and eight miles long. It is said that plans and specifications for the canal are nearly ready for bidders.

A CONCESSION FOR A PERUVIAN RAILWAY from Oroya to Cerro de Pasco, about 60 miles, is offered by the Peruvian Government, and bids for the concession are invited by the Peruvian Director of Public Works. Oroya is the present terminus of the Central Railroad of Peru and Cerro de Pasco is a famous silver mining region about 14,000 ft. above sea level. Particulars of the concession have been furnished to the State Department at Washington by Hon. Irving B. Dudley, U. S. Minister to Peru.

LOCOMOTIVE RUNS in passenger service have been recently increased in length on the Baltimore & Ohio R. R., to such an extent that the number of locomotives required for regular trains has been reduced by 24. Under the new plan locomotives are double-crewed, and make 7,000 to 8,000 miles per month.

A LARGE TANK LOCOMOTIVE for the Dominion Coal Co.'s line in Cape Breton, is a decided departure from ordinary American practice. The engine has eight driving wheels, a leading pony truck, and a four-wheel trailing-truck under the cab and boiler. The tanks are on each side, as in European practice, and extend from the cab to the smokebox. The engine somewhat resembles the Madison Hill pusher engine of the Pennsylvania Lines, illustrated in our issue of June 10, 1897. It was built in 1896 by the Rhode Island Locomotive Works, of Providence, R. I., now operated by the International Air Power Co. The track is of standard gage, and the leading dimensions are as follows:

Driving wheels	4 ft. 2 ins.
Wheelbase, driving	14 ft.
Wheelbase, total	34 ft. 6 ins.
Weight on drivers	154,200 lbs.
Weight, total	215,000 "
Cylinders	21 x 26 ins.
Boiler, straight top; diameter	5 ft. 6 ins.
Firebox	114⅛x42¼ "
Tubes, 277; outside diameter	2 "
Tubes, length	12 ft. 3¼ "

THE MOST SERIOUS RAILWAY ACCIDENT of the week occurred on June 18, when a Northern Pacific freight train collided with an excursion train between Astoria and Linton, Ore. One man was killed and five persons injured. Both engines were badly damaged and two live stock cars wrecked, the stock being killed. The cause of the accident is said to have been a misunderstanding of train orders.

A PECULIAR ACCIDENT ON THE BROOKLYN Bridge occurred on June 19. As a train was starting from the New York station the electrical contact shoe on one of the cars caught on the end of one of the third rails, supported on insulators, and tipped it over. The tipping of this rail was followed by others across the whole length of the bridge, throwing the electric service out of use. Some 6 to 7 hours were required to replace the rail, during a part of which time all traffic on the third-rail system was blocked.

A POWDER MILL EXPLOSION occurred on Point San Pedro, four miles from San Rafael, Cal., on June 17. Four employees were killed, three seriously injured and six buildings wrecked and burned. The works were owned by the United States Smokeless Powder Co.

A COAL MINE EXPLOSION occurred at the Caledonia Mine, Glace Bay, Cape Breton, on June 16, killing 13 or more men and leaving the mine on fire. The mine is owned by the Dominion Coal Co.

THE STEAMER "MACEDONIA" WAS SUNK on June 13, near Long Branch, N. J., in a collision with the "Hamilton," of the Old Dominion Line. The collision occurred in a fog. No lives were lost.

THE GROUNDING OF THE "BROOKLYN" on May 30, in New York Harbor, is ascribed by the Court of Inquiry to the vessel striking upon an unknown and totally submerged wreck.

THE LOS ANGELES OUTFALL SEWER is causing much anxiety to the officials in charge. The present trouble is confined to the mortar used in laying and plastering the brick section and to the iron work of the chambers and manholes. Both the mortar and the iron are disintegrating so rapidly that the conduit will last only six or eight years more, unless the trouble is stopped. The disintegration is quite uniform from the lower end of the three-mile inverted siphon downwards, except where the conduit is covered with sewage, and in the upper part of manholes, where the gases are more dilute. Experiments are now being made with asphaltic and paint coatings and a system of ventilation is proposed. The above information was kindly furnished, at our request, by Mr. Frank H. Olmsted, City Engineer of Los Angeles. The outfall sewer was described at length in Engineering News of Feb. 28, 1895, from which issue the following particulars are taken: It has a total length of 12.4 miles, about seven miles of which is wooden stave pipe. The three brick sections are mostly of 40-in. circular, two-ring brick work. All the cement used was English Portland (Gillingham brand), costing $2.90 and $2.95 per bbl. laid down on or near the work. It was supplied to the contractor by the city. The mortar in which the bricks were laid was composed of 1 part cement and 2 parts of sand. The inside plastering, ½-in. thick, was of neat cement. The bonds for the outfall sewer were voted on Nov. 1, 1892, and the sewer was opened on March 9, 1894. Mr. Burr Bassell, Assistant City Engineer, author of the article from which these citations are made, stated in 1895 that the "brick and concrete work were both exceptionally good."

WATER FILTRATION EXPERIMENTS are in progress at Washington, D. C., under the direction of Colonel Miller, who is in charge of the Washington aqueduct. A government appropriation of $8,000 is available for the work. Slow sand and mechanical filtration will be studied.

THE DAMS IN THE ILLINOIS RIVER may be removed as a result of the construction of the Chicago Drainage Canal. They were built to provide slackwater navigation for boats of 5 to 7 ft. draft, but the landowners claim that they cause much damage to farm lands by flooding. There are four of these dams. Those at Henry and Copperas Creek are owned by the state, and cost about $810,000. They will be removed by the Drainage Board. Those at La Grange and Kampsville were built by the Federal government at a cost of about $1,200,000, and there is now a movement to induce the government to remove them. The Kampsville dam is 30 miles above the junction of the Illinois and Mississippi rivers, and is about 7 ft. high and 1,000 ft. long. The La Grange dam, 45½ miles further up, is 7.83 ft. high and 818½ ft. long. The Copperas Creek dam is 59½ miles distant, and is 6¼ ft. high and 640 ft. long. The Henry dam is 59½ miles further up stream, and is 6½ ft. high and 540 ft. long, forming a pool which extends to Utica, 33⅓ miles. The Hennepin Canal enters the Illinois River about midway between Utica and Henry, Ill. It is said that the flow from the Drainage Canal will give a minimum depth of 7 ft. of water all the way to the Mississippi River, with a depth of 9 ft. from Peru to Henry. Whether the current flow with the increased volume of water would not be so swift as to interfere with navigation is a matter which apparently has not been investigated.

THE IMPROVEMENT OF THE TENNESSEE RIVER is under discussion by a subcommittee of the Committee on Rivers and Harbors, and this committee has just made an inspection of the proposed work. The people of East Tennessee, says the "Globe-Democrat," of St. Louis, have asked for the removal of two obstacles, between Chattanooga and Riverton, at an estimated cost of $3,500,000. One of these is at the "The Suck," covering about 17 miles of the river just below Chattanooga, where the river contracts to a width of 300 to 400 feet, and then expands twice to 2,000 feet in width. In this contraction the water has a velocity of 9 to 10 miles per hour and steamboats have to be warped through; in the broad part there is only 15 inches depth at low water. A dam is proposed for the end of these shoals; the dam to be 25 ft. high and 1,200 ft. long. The Cumberland shoals, 126 miles below Chattanooga, are 8 miles long, and during low water they are absolutely unnavigable. In 1890 a board of engineers recommended the building of a canal around these shoals at a cost of $2,500,000, and work was commenced in 1892, but owing to the unprecedented high water of 1897 it was found necessary to increase the height of the embankment at an additional cost of $1,180,000. Plans for cross-dams are now being considered to replace the canal scheme, and Congress will be called upon to decide. The two cross-dams proposed by Major Kingman, U. S. Engineers, would be 4 miles apart and 1,300 and 1,700 feet long, and 17 and 20 feet high respectively. They would give 6 feet of water at extreme low water.

THE WORK ON DRY-DOCK No. 3 in the Brooklyn Navy Yard is to be investigated in the courts. Suit has been brought by the government against T. & A. Walsh, the contractors who finally completed the work.

IRON MINES ARE TO BE REOPENED as a result of the recent advance in the price of iron. The famous Tilly Foster mine, near Brewsters, N. Y., which was at one time a large producer and has been closed for the past two years, is to resume operations at once.

A 25% INCREASE IN THE WAGES of 45,000 men in the iron and steel industries of this country was decided upon at a joint meeting of representatives of iron and steel manufacturers and the Amalgamated Association of Iron, Steel and Tin Workers, held recently at Detroit, Mich. This brings the wage rate up to that of 1892.

A MOTOR VEHICLE SHOW was opened on June 17 by the Automobile Club, at Richmond, England. A procession of vehicles first ran from Whitehall to Richmond. A motor vehicle service is being operated between Trafalgar Square and Richmond, making four trips daily.

A NEW DEPARTURE IN RAILWAY ACCOUNTING is the establishment of a "clearing house" by the Vanderbilt railways to deal with the distribution of joint traffic earnings between the different companies. As described in "Bradstreet's," of June 17, a duplicate waybill of all shipments passing over two or more roads in the system is sent directly to the clearing house, which calculates the proportion of the freight due to each road, and furnishes monthly statements of balances to each company. Weekly estimates of earnings are also made up from which the debtor companies make remittances on account. The new system is more prompt than the old, and accomplishes the same results with one-third the clerical labor. The clearing house has its headquarters at Buffalo, and now handles the accounts of the New York Central lines, the Michigan Central, Lake Shore, Nickel Plate, Canada Southern, West Shore and Pittsburg & Lake Erie railways. It is stated that the Lackawanna, the "Big Four," and the Reading may soon become members of the clearing house.

BRIDGES OVER THE WHITEWATER RIVER AT RICHMOND, IND.

There are a number of interesting bridge structures in the neighborhood of Richmond, Ind., most or all of which have never been described in technical journals. An inquiry recently addressed to this journal concerning one of these bridges resulted finally in our securing the photographs herewith reproduced, together with interesting facts concerning the various structures, through the courtesy of Prof. R. L. Sackett, C. E., of the department of applied mathematics and astronomy, in Earlham College, Richmond, Ind.

The old National bridge, Fig. 1, was built about 1834, and was removed in 1897, after it had sagged about 5 ins. It spanned the Whitewater River, and was a part of the great national highway extending from Cumberland, Md., through Pittsburg, Columbus, Richmond and Indianapolis to Terre Haute. It was intended to reach St. Louis, but was overtaken and outclassed by the railway. The river is a shallow stream, running between steep banks of limestone rock. The foundation was a timber grillage, laid in treacherous quicksand; and there is a tradition that "wool-sacks" were used under this grillage. The abutments were built of limestone, and these and the curved wingwalls stood until ½-in. cracks extended from the bottom to the top.

FIG. 1.—BRIDGE ON THE OLD NATIONAL TURNPIKE, AT RICHMOND, IND.
Built by Gen. John Milroy, in 1830. Taken Down in 1897.

FIG. 2.—MITCHELL STEEL CABLE BRIDGE OVER WHITEWATER RIVER, AT RICHMOND, IND.
Built by Mitchell Bridge Co., 1889. Washed away, 1897.

The Doran three-hinged wrought-iron arch, Fig. 3, was built by the Morse Bridge Co., of Youngstown, O., from the designs of the late Frank C. Doran. It is 400 ft. span between skewbacks, and 576 ft. long over the floor. There are two end suspended spans of 64 ft. each. The two arches are in vertical planes, 25 ft. apart, and the roadway is 41 ft. wide between railings, including two 8-ft. footways supported on the ends of the floor-beams. The floor, at the crown, is 65 ft. above the water and 50.66 ft. above the spring line; the arch is 10.66 ft. deep at the crown. The upper chord has a radius of 27,676 ft., and the lower chord a radius of 520 ft. The floor system was figured at 30 lbs. per sq. ft., with a moving load of 28 lbs. per sq. ft. The bridge cost $58,000.

It was designed for street traffic only, but electric cars, with trailers, are now operated on one side of the 25-ft. roadway; and under the heavy loads the bridge shows a very appreciable lateral and vertical motion. The vertical arches, 25 ft. apart, are now hardly equal to the traffic demands of a city of 22,000.

In the distance, in Fig. 3, is the Pennsylvania R. R. bridge. This has one 150-ft. span of the Baltimore Bridge Co.'s truss, and two double intersection spans; all deck trusses.

Fig. 4 is the new Main St. bridge, built to replace the old National bridge, shown in Fig. 1. It is a deck structure of several spans, the longest being 160 ft. The floor is on a grade of 2.5%, and is made of expanded metal plates and concrete, with asphalt on top. It is a very heavy floor; and it is said that the bridge was originally designed for a cedar-block floor, and the change was made during construction. The roadway is 30 ft. wide, with two 5-ft. footways. The total length is about [illegible] ft., and it cost over $60,000.

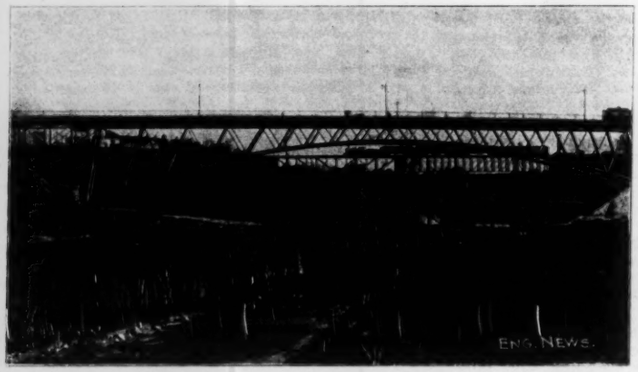


FIG. 3.—THREE-HINGED WROUGHT-IRON ARCH BRIDGE OF 408-FT. SPAN, AT RICHMOND, IND.
Built by Morse Bridge Co., Youngstown, O. Designed by Frank C. Doran.

FIG. 4.—NEW MAIN ST. BRIDGE, RICHMOND, IND.

The superstructure was made up of three white-oak arches and a light truss; there were two roadways and two footwalks carried on the floor beams extended. It was one of the many timber bridges built by Gen. John Milroy in the early 30's.

The Mitchell steel-cable bridge, Fig. 2, was built in 1889, and crossed the Whitewater River about 1½ miles below the old National bridge. It was 200 ft. long between the anchorages, and 150 ft. span. It was built in 30 days.

The builder's advertisement at the bottom of the photograph here reproduced reads:

> It cost $2,150 for sub and superstructure complete, or about one-fourth of the cost of other iron bridges, and equal to them in strength and superior in durability, as there is no wood except the floor, and it rests on galvanized steel cables, so anchored that it cannot be washed away.

It stood eight years and was washed away in 1897, notwithstanding its builder's advertisement. A person standing at the quarter-point of the span, and teetering, could make the bridge vibrate through a vertical distance of 12 to 18 ins. Some of the erection features were novel enough. The cables were brought to a proper tension by thrusting a lever through the strands and then twisting it up to the supposedly proper stress; to hold it, the lever was then pushed through until it bore upon the ground. The "stiffening girder" had a strap-iron top chord and all diagonals were round iron. It is needless to say that this structure had no engineer connected with it; the county commissioners were their own engineers.

FLANGED TIRES FOR MOGUL, TEN-WHEEL AND CONSOLIDATION LOCOMOTIVES.*

The question submitted to the committee was: Is it desirable to have flanged tires on all the drivers of mogul, ten-wheel and consolidation engines? If so, with what clearances should they set?

The desirability of using flanged tires on all the driving wheels of mogul, ten-wheel and consolidation engines depends on certain conditions which have to be taken into consideration, and these are as follows: (1) Length of rigid wheel base; (2) Length of total wheel base; (3) Are rigid or swing-motion engine trucks used? (4) Lateral motion between driving box and hub, when engines leave shop; (5) Lateral motion between engine truck box and hub, when engines leave shop; (6) Degree of curvature on line where engines are to be operated; (7) Practice of Roadway Department as to the gage used on curves. In order to bring out these points, the committee issued a circular Nov. 18, 1898, and a summary of the information received in reply to the circular is as follows:

	All flanged.	1 and 3 fl'ng'd.	2 and 3 fl'ng'd.	1 and 4 fl'ng'd.	1, 3 and 4 fl'ng'd.	Total.
Mogul	440	743	...	....	...	1,183
Ten-wheel	534	1,048	702	....	...	2,284
Consolidation.	348	....	...	1,313	405	2,066
Total	1,322	1,791	702	1,313	405	5,533

	Longest rigid wheel base. All flanged.	Longest rigid wheel base. Partly flanged.	Longest total wheel base. All flanged.	Longest total wheel base. Partly flanged.
	ft. ins.	ft.	ft. ins.	ft. ins.
Mogul	16 1½	16	23 0	23 10½
Ten-wheel	14 4	16	24 10	26 6
Consolidation	16 3	16¼	24 2	24 6

*Abstract of committee report presented at the annual convention of the American Railway Master Mechanics' Association, at old Point Comfort, Va., June 19 to 23, 1899.

A swing-motion engine truck is used with the three types of engines having all tires flanged, the motion being 1½ ins. each side of center. The same practice prevails with mogul, consolidation and many ten-wheel engines having tires partly flanged, but about 50% of the ten-wheel engines with tires partly flanged have rigid trucks. No matter whether engines of the types referred to have flanged tires on all driving wheels or not, the prevailing practice when such engines leave the shop is to have the lateral motion in each driving box ⅛-in., and the same with each engine truck box. With tires partly flanged, the distance between backs of flanges for each type of engine covered by this report appears to be 4 ft., 5¼ ins. In the case of engines having flanged tires on all driving wheels, the same practice prevails for mogul and ten-

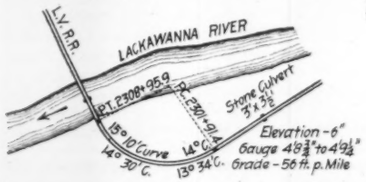


Fig. 1.—Sketch Plan of Railway Curve Employed in Testing Resistance Offered to Different Arrangements of Flanged and Flangeless Locomotive Driving-Wheel Tires.

wheel engines. The prevailing practice with consolidation engines having flanged tires on all driving wheels is to have the distance between flanges on first and fourth pair of wheels 4 ft. 5⅛ ins., and on the second and third pair of driving wheels 4 ft. 5¼ ins.

The sharpest curvature reported from roads using all-flanged tires is 18°; the sharpeest curvature reported from roads that use engines with driving wheels partly flanged is 16°. On a majority of roads that have replied to the circular, the track is laid wide of gage on curves, but there does not appear to be any exact ratio between the degree of curvature and the amount that the gage is widened.

The roads using flanged tires on all driving wheels, also the roads using flanged tires on a part of the driving wheels, report that their practice has not caused any trouble, and the benefits resulting from each practice are claimed to be as follows: (1) With flanged tires on all driving wheels: Less flange wear, as the pressure between the flange and the rail is distributed more; more uniform wear of flanges and driving wheel hubs; as the tires wear down, the flange gives them greater strength, and there is less liability of thin tires slipping on center; it is necessary to carry but one kind of tire and brake shoe in stock; engines ride better on curves and there are less derailments. (2) With flanged tires on a part of the driving wheels, it is claimed that there is less flange wear, engines curve easier, less liability of climbing the rail, less wear of rail heads. Less trouble with sharp flanges.

It will be seen from the above that the advantages claimed from each point of view are about the same, with the exception that the roads using flanged tires on all driving wheels have the advantage as to the variety of tire and brake shoes to be carried in stock, and as to the strength of the tire when reduced in thickness by wear.

In order to obtain information as to the resistance offered by a locomotive when passing through a sharp curve, the committee decided upon making some tests with a consolidation locomotive, assuming that that type of engine would represent the worst conditions. The tests were made on the tracks of the Lehigh Valley R. R. near Coxton, Pa., on a curve, as shown in the accompanying sketch, Fig. 1.

The engine with which the tests were made was of the consolidation type. The spacing of the wheels, weight on each pair of wheels, etc., are shown by Fig. 2. The engine was just out of the shop; lateral motion in each driving box ⅛-in.; lateral motion in each truck box 5-32-in.; swing-motion engine truck, motion either side of center, 1½ ins.; main rods and valve rods disconnected, and boiler full of water. The tests were made by hauling the engine through the curve at Coxton, entering the curve at the lower end, so as to have the grade to contend with, viz., 56 ft. per mile. The coupling between the engine being tested and the engine that was used for moving it was made by means of a dynamometer, a drawing of which is shown by Fig. 3.

Three series of tests were made, the first test being made with flanged tires on 1st and 4th pair of wheels, plain tires on 2d and 3d pair of wheels. The second test was made with flanged tires on 1st, 3d and 4th pair of wheels, plain tires on 2d pair of wheels. The third test was made with flanged tires on all driving wheels. The tires used were new, Master Mechanics' Standard Section; width of flanged tires, 5¾ ins.; width of plain tires, 6½ ins. In test 1 and 2 the flanged tires were located so that the distance between backs of flanges was 53⅛ ins., while the distance between the inside of plain tires was 52⅛ ins. In the third test the distance between flanged tires on first and 4th pair of wheels was 4 ft. 5⅛ ins.; on the second and third pair of wheels 4 ft. 5¼ ins. The plain tires were located on driving wheel centers, so that the center of the tread of the tire coincided with the center of the rail head on straight track. In connecting the dynamometer between the two engines no springs were used, as the draw castings on each engine were bolted solid.

Several trips were made with each arrangement of flanged tires and plain tires, and readings were taken on each trip, while the engine was being pulled through the curve. A uniform speed of 28 miles per hour was maintained during each trip, except the last trip of each test, when the speed was reduced to 5 miles per hour. A sum-

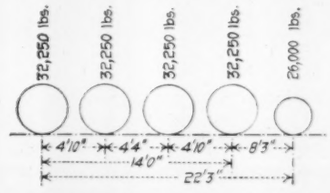


Fig. 2.—Driving-Wheel Arrangement of Consolidation Locomotive Tested to Determine Resistance to Passing Curve Shown by Fig. 1.

mary of the readings taken on the different trips showed that the power required to pull the engine through the curve with the different arrangement of tires was practically the same. The members of the committee are not prepared at this time to make any recommendation as to the desirability of using flanged tires on all driving wheels of mogul, ten-wheel and consolidation engines,

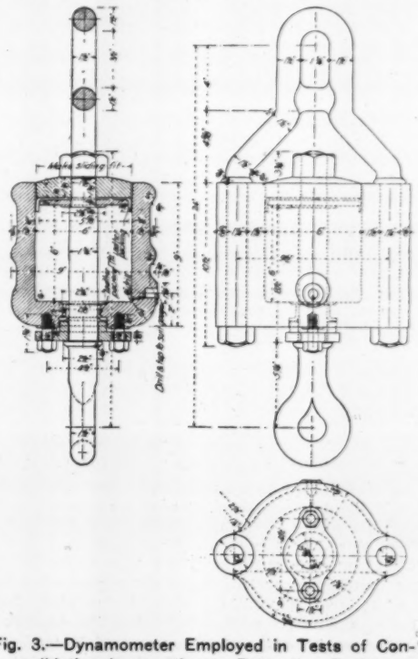


Fig. 3.—Dynamometer Employed in Tests of Consolidation Locomotive to Determine Resistance in Passing Curve Shown by Fig. 1.

but have presented all the information on the subject that they have been able to gather, and the committee now suggests the advisability of the investigation being continued, so that a final report can be made to the convention to be held in 1900. If this is thought advisable by the Association, the committee would recommend the use of a self-registering dynamometer, and that tests should be made on straight track, as well as on a curve, an attachment to be used so as to indicate the lateral motion of the engine on straight track, at maximum speed, with the different tire arrangements.

THE BELLEFIELD ARCH BRIDGE, IN SCHENLEY PARK, PITTSBURG, PA.

(With two-page plate.)

This handsome stone arch of 150-ft. span is located at the entrance to Schenley Park, in Pittsburg, Pa., and is close beside the Carnegie Library Building. It carries the road leading to this park over a ravine about 70 ft. deep, commonly known as St. Pierre Hollow. The bridge is 341 ft. long and 85 ft. 6 ins. wide from out to out, and it consists of a single segmental stone arch of about 150 ft. span and 36 ft. 7 9-16-in. rise, with abutments and wing walls. The arch measures 82 ft. in width across the soffit, and carries a roadway 59 ft. wide, and two footways of 10 ft. each.

The foundation for the structure is of Portland cement concrete, resting upon solid rock, as shown in Fig. 2. All concrete was made of 1 part Saylor's Portland cement, 2 parts of river sand and 4½ parts of Ligonier stone broken to pass through a 2-in. ring. The excavation about the foundations was large enough to permit men to work readily outside the walls, and this space was afterwards filled with good clay and well tamped.

The material used for the bridge was gray sandstone, the objection to which, however, is that it does not hold its color very well, and the discoloration already apparent considerably mars the appearance of the structure. The ringstones are 4 ft. deep at the crown, gradually increasing to 6 ft. at the springing lines. Measuring in 7 ft. from the face of the head walls, the sheeting stones are of the same dimensions as the ringstones; but all other sheeting stones are 4 ft. deep. Both sheeting and ringstones were cut with ¼-in. joints, and rough-pointed on the soffit. The minimum length of any stone was 4 ft., and no break in joint of less than 18 ins. was permitted. The crown of the arch, after the rings and sheeting were set, and for a distance of 30½ ft. each way from the centre of the span, was covered with a mass of Portland cement concrete extending up to the subgrade of the roadway. The remainder of each half-arch was then covered with a layer of concrete, increasing in thickness from 18 ins., above the crown to 4 ft. near the springing line of the arch. Care was taken that the extrados of the stone arch was left as rough as possible so as to bond well with the concrete, as shown in Fig. 5.

On this concrete backing, and above the springing line on each side, was built a retaining wall in line with the face of the abutments, and carried up to subgrade. Between these retaining walls, and on the concrete backing were placed 27-in. spandrel walls of rubble masonry, arranged to form openings, or wells, 8 ft. 6 ins. × 9 ft. 6 ins. The crosswalls were stopped before reaching the double skewback placed on the longitudinal walls, and the openings between the latter were spanned by 13-in. brick arches. These brick arches were then covered with natural cement concrete to subgrade of the roadway, and over this concrete was placed a ⅝-in. layer of rock asphalt, and above this 12 ins. of broken stone.

The head and wingwalls were all laid in range work, backed with rubble, and the space between the wingwalls and the retaining walls was filled in solid with clay up to the subgrade of the macadam pavement. The concrete over the arch was laid so as to drain to the back of the retaining wall, and any seepage water was there collected and carried by a pipe through the wingwall. This arch-concrete was smoothed by covering it with a 1-in. layer of Portland cement mortar. All of the concrete used was mixed in small batches, laid in thin layers and thoroughly rammed. The mortar employed in all arch work was made of 1 part Saylor's Portland cement to 2 parts of river sand; the remainder of the work was laid in natural cement mortar.

Ground was first broken for the construction of this bridge on July 10, 1896; and in the course of the following fall a few courses of sheeting were laid, though only seven courses were in place at each end on June 1, 1897. No attempt was made to put any load upon the centers until a considerable amount of stone was in the yard, and the quarries were in such shape that the builders were confident of closing the arch without interruption. The arch was keyed on Sept. 18, 1897, and from Sept. 30 the centers were lowered very gradually by taking a little sand out of the cylinders every day, beginning at the center of the span and working each way. The centers were well away from the arch on Oct. 12. The crown of the centers was originally set 2 ins. above the intended height of the finished arch, and by the time the arch was keyed the crown of the center had gone down 0.0555 ft., or a little more than ⅝-in. After the

centers were struck the crown of the arch settled 0.155 ft., making a total settlement of 0.2105 ft., leaving the soffit of the arch 0.0372 ft., or about 7-16-in. lower than was calculated. The total settlement, in all probability, would have been somewhat less had not the centers been allowed to remain loaded for so long a time.

The centers were designed by Mr. A. D. Neeld, of the contracting firm of Neeld & Foley. They consisted of 14 ribs arranged as shown in Fig. 3, placed 6 ft. 2 ins., c. to c., and resting on cast-iron cylinders filled with sand. This sand was dried and sifted before being placed in the cylinders, and when in place they were protected from moisture by cement. The cylinders were 12¼ ins. inside diameter, except those under the central row of posts, which were 14¼ ins. diameter. Each cylinder had two sliding gates covering 1-in. holes, and their working was eminently satisfactory, giving no trouble whatever. The centers were built of hemlock timber, of which about 450,000 ft. B.M. was used. Before beginning to lay sheeting the joints in the falseworks were carefully gone over and oak wedges were inserted wherever thought necessary. After the sheeting was laid up to the haunches, the crown of the centers was loaded with sheeting, which was built into the work as it was reached. The pieces of center connecting the tops of the posts were not cut to a radius as usual, but the curve was secured by wedging up each piece of the lagging to its proper elevation.

For setting the voussoirs, one of the inspectors of the work, Mr. J. G. Parke, devised a very efficient setting-square, called by the workmen "Parke's Fiddle," and shown in Fig. 7.

Some cracks appeared in the joints of the sheeting during construction, due to the settlement of the false-works. At both sides and between the 12th and 13th ringstones from the spring, a crack extended clear across the arch, 5-32-in. wide in one case, and ¼-in. in other. Between the 13th and 14th ringstones on one end 1-16-in., and 1-32-in. cracks appeared for a distance of 16 ft., and 26 ft. from the face, respectively. A 1-16-in. crack went across the arch on one side, between the 21st and 22d rings—jumping one course 20 ft. from one end to the 20th and 21st rings; on the opposite side was a similar 1-16-in. crack at the corresponding rings, but also jumping one course on the opposite face of the arch. These cracks were carefully grouted with cement before the centers were struck.

All the cement used was Saylor's Portland and Black Diamond brand of Louisville cement, with a small amount of other brands. All of this cement was carefully inspected, and two tests were made from every fourth barrel.

The roadway has a grade of 0.8%, falling both ways from the center of the bridge, though the top of the railing is level from out to out of end piers, and then falls 0.8% to the ends of the wingwalls. The roadway itself is macadam, with cement sidewalks. The photograph reproduced in Fig. 1 was taken from the end nearest the park, looking towards the Hotel Schenley, which appears at the left. The appearance of the bridge on this side will be very much improved when the grounds are put into proper shape. At the present time the side nearest Forbes St. is partially buried; but it is the intention to grade off the banks on that side and fill in the bottom of the ravine, and to form a lake under the bridge, which will give this graceful structure a much more pleasing setting.

During the construction the inspector on the work was required to send in a daily report to the engineer's office setting forth the following: Kind of work; location of work; men employed by either contractor or city started and stopped work at hour given; and the cause and duration of any stoppage meanwhile. A detailed force account followed; with class and approximate amount of work done, and amount and character of all material received on the work. On the back of this report was a statement of everything that occurred on the work that might be of interest or service at some future time. In this manner the engineer obtained a complete record of each day's work with all important incidents during progress.

The cost of the bridge and final estimate for quantities is given as follows:

Contract price bid	$109,902
Extra work on foundations	2,290
Cost of bridge complete	$112,201

Final estimate of quantities:

Sheeting	2,451 cu. yds.
First-class masonry	3,829 "
Portland cement concrete	3,135 "
Natural cement concrete	405 "
Rubble masonry	1,912 "
Brickwork	372 "
Total masonry	12,358 "
Macadam pavement	2,059 sq. yds.
Cement sidewalk	815 "
Stone gutters	151 "
Asphalt under roadway	706 "
Curb	682 lin. ft.
Excavation	1,550 cu. yds.
Fill	7,250 "

The bridge was built under the direction of Mr. E. M. Bigelow, M. Am. Soc. C. E., Director of the Department of Public Works.

Mr. William Falconer is Superintendent of the park in which it is located.

The bridge was designed by Mr. Henry B. Rust, Assoc. M. Am. Soc. C. E., Engineer of Schenley Park, who was also engineer-in-charge of construction, and to his courtesy we are indebted for the material employed in this article. The contractors were Neeld & Foley, of Pittsburg, Pa.

The plant used by Messrs. Neeld & Foley was so efficient in commanding the work and in supplying material that a diagram is here given of its location (Fig. 6) which explains itself.

THE SLOW SAND FILTRATION PLANT FOR LITTLE FALLS, N. Y.

A slow sand filtration plant, containing some unique features, is being built for the city of Little Falls, N. Y. A single bed, about one acre in extent, forms the filtering area. By the adoption of a device invented by the engineer, and shown in the accompanying illustration, the usual layers of coarse, medium and fine gravel beneath the filtering sand are entirely omitted. The filtering sand is only 2 ft. deep, so the excavation and embankment is much less than would be required with the ordinary depth of 4 to 5 ft. of draining and filtering material.

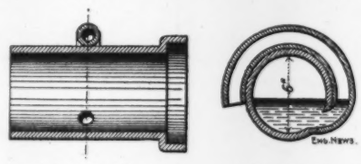
The plant was designed by Mr. S. E. Babcock, and had been carried on well towards completion under his direction, when the contractor abandoned the work, and cold weather postponed it until this season.

Mr. Babcock was engineer for the original waterworks of Little Falls, and continued to serve in the same capacity through numerous improvements and extensions until a few weeks ago, when he resigned his position as City Engineer.

The population of Little Falls in 1890 was 8,783. Water-works were built by the municipality in 1885-8. The source of supply was Beaver Creek, the diverting dam being at an elevation of 1,185 ft. above the railway tracks in the city. From this dam the water flows through a conduit about nine miles long to a 25,000,000-gallon distributing reservoir. The greater part of this conduit is of 20 to 12-in. vitrified clay pipe, the diameter varying with the grade. On sections having much head cast iron was used instead of vitrified pipe. Near the distributing reservoir the water flows for 1,600 ft. through an aerating canal, provided with 16 2-ft. drops, or weirs, 10 ft. wide at the top and 3 ft. wide at the bottom. Provision is made for flushing out deposits from the pools in the canal. From the lower end of the canal the water passes through a 12-in. cast-iron pipe to the center of the reservoir, where it is discharged over a masonry pier extending 1½ ft. above the water surface. At the reservoir outlet the water passes down through a coke filter, 8 × 12 ft. in plan and 40 ft. deep, provided with the necessary pipes for washing the coke by reversing the flow.

From Mr. Babcock's report on construction, and the annual reports of the water department, it appears that the aerating canal and coke filter were designed to clarify the water and to remove organic matter of vegetable origin, at the same time preventing tastes and odors due to the development of low forms of organic life in the distributing reservoir. It also appears from the reports named that the quality of the supply has been very satisfactory, with one exception, but this is probably very largely due to the natural quality of the water, Beaver Creek being described as a mountain trout stream. The exception was in 1891, a very dry year, when the water had a bad taste. This was attributed to the logs, branches and leaves of trees in the creek, the accumulation of years. After removing these, and renewing the coke for the first time in five or six years, the water became satisfactory. Mr. Babcock states that spongilla, or fresh water sponges, developed during the troublesome period just mentioned. As time has elapsed the yield of the stream has decreased materially, and the consumption has, of course, increased. To provide amply for the future, Mr. Babcock designed, and the city put under construction, within the past two or three years, two large storage reservoirs, with capacities of 750,000,000 and 100,000,000 gallons, respectively. These are located on Spruce Creek, at such elevations as to permit their connection by a gravity conduit with the original Beaver Creek conduit, which has a safe carrying capacity of about 5,000,000 gallons a day.

The sand filter bed is located at the lower reservoir or point of diversion of Spruce Creek into the original conduit to the city. It was deemed advisable to put this in on account of the character of Spruce Creek, the new water supply. This stream drains a hemlock and spruce watershed. The water is discolored, and carries considerable sediment. An experimental filter, 1-40 of an acre in area, was constructed, filled with 2 ft. of sand found near the filter bed. By experimental tests the right kind and size of sand was found that effectually cleared the supply at a rate of 3,000,000 gallons an acre. The expense of enlarging and



Longitudinal Section. Cross Section.

Underdrain Used in the Filter Bed at Little Falls, N. Y.
S. E. Babcock, Engineer.

clearing the coke filters in the distributing was found by estimate to be much more expensive than the sand filter plan adopted for the additional supply.

The filter bed is approximately 130 × 300 ft. It is located on the site of the overflow of an old timber dam, now being reinforced by a masonry structure. The site was mostly natural rock, which required some leveling-up. Embankments were necessary on the side nearest the creek and at each end. A head wall is built in the lower embankment, and a heart-wall carried from it about one-fourth of the way up the long side embankment. Sheet-piling, built in a trench, is placed the whole length of the upper embankment. The site was brought to grade by leveling it off with stone and gravel, care being taken to so place the stones that the filtering sand would not work down between them.

A gathering culvert is built longitudinally through the center of the bed. It is about 5 ft. wide and 4 ft. high; has 2-ft. dry rubble walls and a 3-in. plank top. Discharging into this culvert every 6 ft. on either side are 6-in. vitrified pipe underdrains, laid with tight joints, but provided every 6 or 8 ft. with a "Babcock conduit," which is shown by the accompanying sections. It will be observed that these conduits are really siphons, curved around the drain pipes. Their outer mouths come down within 2 ins. of the bottom of the filtering material. Sand cannot pass through them without violating the laws of gravity, so they are in no danger of silting up with sand, provided the pipe joints are tight. These are made with one strand of rope and 1 to 1 cement mortar, the upper end of each line being stopped with a vitrified plug.

The specifications call for filtering material 2 ft. deep, after the water is turned on and the sand

has settled. An allowance of 10% for shrinkage is suggested. The specifications also call for clean, sharp sand, approved by the engineer. After passing through screens with four meshes to the inch the effective size of the sand must be between 0.25 and 0.35 mm. (0.01 to 0.014 ins.), and the uniformity coefficient between 2 and 3.

The special features of the filter, as already stated, are the peculiar form of underdrains and the small depth of the filter bed, the former making the latter possible. The depth of sand is not so much below the average, but the entire absence of the usual supporting layers of gravel, with the underdrains at the bottom, is unique. It has been known for many years that the bulk of the work of filter beds is done by the upper layers of the filtering sand, but in order to make all the sand available, with the ordinary underdrains, it is necessary to place the top of the latter beneath the bottom of the sand. To facilitate the collection of the filtrate, the underdrains are surrounded with large gravel, or small stone. To keep the sand from settling into the large open spaces in the bed of stone, layers of gravel, of diminishing size, are placed above the stone, until the last layer of gravel, or coarse sand, approaches the fineness of the filtering sand. The peculiar design of the Babcock conduit is calculated to make all this grading of material, and the larger material itself, quite unnecessary, except for a small amount packed around each siphon. Of course, the underdrains cost more than in ordinary practice, but this is said to be small in comparison with the saving in excavation and embankment. Where masonry side walls are employed the saving to be effected by the use of this system would be greater still.

The unfiltered water is admitted to the filter bed through a single 15-in. inlet at one side of the bed, the flow being controlled by a Ross balance valve and float. A similar device is placed in the outlet chamber. In addition, the outlet chamber contains indicators to show the head of water on the outlet weir, on the filter bed and the height of water in the underdrains. Two overflows from the filter bed are provided, one at 4 ft. above the sand surface, for summer use, and one at 6 ft., for winter use. The water is rough-screened before going to the bed. From the outlet chamber an 18-in. main will lead to a connection with the present supply main from Beaver Creek.

The contract price for the new stone dam and the filter was $17,748, of which Mr. Babcock estimated at the outset the filter bed would cost $11,750. When the contractor gave up the work, in December, 1898, the city concluded to complete the job by day labor, under the direction of the city engineer. We are indebted to Mr. Babcock for the information from which the above was prepared. He states, under date of May 10, that the filter bed is now practically completed, and will be used during the dry season of 1899, also that the cost has not exceeded the original estimate.

LAYING DOWN TRANSITION CURVES BY OFFSETS.

Various systems of laying out transition curves are in use, different engineers having personal preferences for different systems, and many of these have been described in our columns. We have recently received from Mr. J. P. Newell, Assistant Engineer of the Oregon Railroad & Navigation Co., particulars of a method of laying out such curves by offsets, which has been prepared by him and used extensively on that road. There are several different methods of laying out transition curves by offsets, but most of them are based upon the compound circular curve, while Mr. Newell's method is based upon the cubic parabola, which is usually recognized as being the correct basis of transition curves.

The objection is sometimes made that the method of laying out the curves by offsets is but a rough approximation to the true curve, but such objections (like objections to simple methods of setting out turnouts), are apt to be made on theoretical considerations and without due allowance for the fact that delicate and minute measurements are out of place and useless in track work. Mr. Newell states that many miles of track centers have been run in on his system on the O. R. & N. Co.'s line, and that it would be impossible to distinguish the track thus lined from that on which the centers have been set directly from the transit, while the cost of the work has been very much less.

The accompanying cut shows the transition curve and the method of laying it out. The main offsets and offset distances for curves of even degrees are given in Table I., while Table II. gives

$$F D = 8 \left[\frac{1}{2} S \right] \quad D G + F G = S + d \left[\frac{T}{100} \right]^3$$

$$S + d \left[\frac{T}{100} \right]^3 = 4 S.$$

$$d \left[\frac{T}{100} \right]^3 = 3 S.$$

intermediate offsets and distances. The following are the instructions accompanying the diagram and tables:

The curve is run in the regular manner, and the stakes of the same are then moved inside the necessary distances to correspond with the various offsets for the easement curves.

Length of easement (= 2 T) should be taken so that the full elevation of the outer rail (at a rate of ½-in. in 30 ft.) is reached at the P. S. C.

Use column in tables, headed by ascertained value of T.

To obtain offset S for main curve, multiply S in table by degree of curve.

To obtain offset s for any value of t, multiply s in table by degree of curve.

t = distance from any station on spiral to nearest end of spiral. If station is on curve, offset = S — s.

Example.—5° curve, 500 ft. long. P. C. at station 10 + 50. Elevation, 3½ ins. Length of easement = 2 × 3½ × 30 = 210 ft. = 2 T. Therefore, T = 105 ft. Nearest value by table is 105.8 ft., and this is to be used.

P. S. = (10 + 50) — (1 + 05⁸) = station 9 + 44².

P.S.C. = (10 + 50) + (1 + 05⁸) = station 11 + 55⁸.

Offset for main curve = S = 0.325 × 5 = 1.625 ft.

For station 10, t = 56 ft., nearly, and s = .024. Therefore, offset = .024 × 5 = 0.120 ft.

For station 10 + 50 (P. C. of simple curve), offset = ½ s = 0.81 ft.

Since station 11 is on the curve, the offset = S — s, = 1.625 — (.024 × 5) = 1.50 ft. (t = 56 ft.).

At station 11 + 55⁸ (= P. S. C.) the offset = S = 1.625 ft.

The same operations are performed at the other end of the curve.

TABLE I.

Curve.	Elevation of outer rail.	Value of S., ft.	Value of T., ft.
1°	1½ ins.	0.0	....
2°	2 "	0.3	71.9
3°	2½ "	0.6	83.0
4°	3 "	1.0	92.8
5°	3½ "	1.63	105.8
6°	3⅞ "	2.40	117.4
7°	4¼ "	3.50	131.2
8°	4⅝ "	4.60	140.7
9°	5 "	5.85	149.6
10°	5 "	6.50	149.6

No extra instrument work is required, and no extra notes, except a note of the value of "S."

The offsets can all be calculated in a few minutes. It is customary for the head chainman to carry a supply of small pegs, which he drives in the ground on exact line, and from which the stakeman measures the offsets, thus permitting the chainmen to pass rapidly over the work without waiting for stakes to be driven. Since the tables by interpolation admit of an infinite number of spirals it is not necessary to re-run a curve for a slight error in closing at the P. T., but a new spiral can be chosen which will exactly fit the desired tangent.

For the benefit of those of our readers who may wish to study up the matter and compare the above system with others which have been described, we give the following references to articles and letters which have appeared in our columns:

Vol., January—June, 1892, p. 39.
" July—December, 1892, pp. 451, 542, 610.
" " 1893, pp. 277, 316, 372, 456, 476.
" " 1896, p. 245.
" January—June, 1897, pp. 75, 234, 267.

PROPOSED NEW CONTOUR LINES AND NEW SPECIFICATIONS FOR M. C. B. COUPLERS.*

This topic may be divided into three parts: (1) To define the contour lines more fully when new; (2) to define the contour lines more fully when worn; and (3) to propose specifications for couplers.

Contour Lines for New Couplers.—In regard to the length of guard arm, it is recommended that the contour lines be extended about 1 in. beyond the point where they at present terminate, and that the M. C. B. limit gages for new couplers have the guard arm screw moved from its present position to a new one at the end of the proposed new contour lines. This proposed contour line is shown by Fig. 1. The only change is in the length of the guard arm; the reverse curve of 8 ins. radius has been straightened out and continued as a tangent to the arc drawn with the 2 3-16-in. radius. It is also reduced in flare so as to hold the couplers together better. There is a limit to which the length of the guard arm may be increased, as after a certain point has been reached, any added length is not only useless but renders the part more liable to damage. It will do very little good simply to prolong the guard arm with the present 8-in. radius, as some makers have done. Couplers of the present contour which have worn to the point of danger would still be safe with the proposed new contour. This new con-

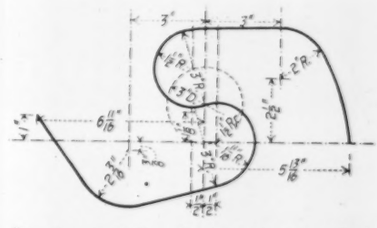


Fig. 1.—Proposed New Contour Lines for M. C. B. Couplers.

*Abstract of committee report presented at the annual convention of the Master Car Builders' Association at Old Point Comfort, Va., June 14 to 16, 1899.

TABLE II.—Easement Curves. (All values are given in feet.)

T =		71.9	83.0	88.0	92.8	97.3	101.6	105.8	109.8	113.6	117.4	121.0	124.5	127.9	131.2
S =		.150	.200	.225	.250	.275	.300	.325	.350	.375	.400	.425	.450	.475	.500
t		s	s	s	s	s	s	s	s	s	s	s	s	s	s
20	.....	.002	.0014	.0013	.0013	.0012	.0011	.0011	.0011	.0010	.0010	.0010	.0009	.0009	.0009
30	.....	.005	.005	.004	.004	.004	.004	.004	.004	.003	.003	.003	.003	.003	.003
40	.....	.013	.011	.011	.010	.010	.009	.009	.008	.008	.008	.007	.007	.007	.007
50	.....	.025	.022	.021	.020	.019	.018	.017	.017	.016	.015	.015	.015	.014	.014
60	.....	.043	.038	.036	.034	.032	.031	.030	.029	.028	.027	.026	.025	.025	.024
70	.....	.069	.060	.057	.054	.051	.049	.047	.045	.044	.042	.041	.040	.039	.038
80	.....	.103	.089	.084	.080	.076	.073	.070	.068	.065	.063	.061	.060	.058	.057
90	.....	....	.127	.120	.114	.109	.104	.100	.096	.093	.090	.087	.085	.083	.081
100	.....	....	....	....	.156	.149	.143	.137	.132	.128	.124	.120	.117	.114	.111
110	.....	....	....	....	....	....	.190	.183	.176	.170	.165	.160	.155	.151	.147
120	.....	....	....	....	....	....	....	....	....	.220	.214	.207	.201	.196	.191
130	.....	....	....	....	....	....	....	....	....	....	....	....	.256	.249	.243
T =		134.5	137.6	140.7	143.7	146.7	149.6	152.5	155.3	158.0	160.7	163.4	166.0	168.6	171.1
S =		.525	.550	.575	.600	.625	.650	.675	.700	.725	.750	.775	.800	.825	.850
t		s	s	s	s	s	s	s	s	s	s	s	s	s	s
20	.....	.0009	.0008	.0008	.0008	.0008	.0008	.0008	.0007	.0007	.0007	.0007	.0007	.0007	.0007
30	.....	.003	.003	.003	.003	.003	.003	.003	.003	.002	.002	.002	.002	.002	.002
40	.....	.007	.007	.007	.006	.006	.006	.006	.006	.006	.006	.006	.006	.006	.005
50	.....	.014	.013	.013	.013	.012	.012	.012	.012	.012	.011	.011	.011	.011	.011
60	.....	.023	.023	.022	.022	.021	.021	.021	.020	.020	.020	.019	.019	.019	.018
70	.....	.037	.036	.035	.035	.034	.033	.033	.032	.032	.031	.030	.030	.030	.029
80	.....	.055	.054	.053	.052	.051	.050	.049	.048	.047	.047	.046	.045	.044	.043
90	.....	.079	.077	.075	.074	.072	.071	.069	.068	.067	.066	.065	.064	.063	.062
100	.....	.108	.106	.103	.101	.099	.097	.095	.093	.091	.090	.089	.087	.086	.085
110	.....	.144	.141	.137	.134	.132	.129	.126	.124	.122	.120	.118	.116	.114	.113
120	.....	.186	.182	.178	.175	.171	.168	.164	.161	.159	.156	.153	.151	.149	.147
130	.....	.237	.232	.227	.222	.218	.213	.209	.205	.202	.199	.195	.192	.189	.186
140	.....	.295	.289	.283	.277	.272	.266	.261	.256	.252	.248	.244	.240	.236	.233
150	.....	....	....	....	....	....	....	.321	.315	.310	.305	.300	.295	.291	.286
160	.....	....	....	....	....	....	....	....	....	....	.370	.364	.358	.353	.348

tour does not cause the couplers to interfere when their axes make an angle of 14°, and does not prevent the possibility of coupling at this angle. The proposed new gage for the new contour is shown by Fig. 2. The change made consists in the extension of the frame and the relocation of the present guard arm limit screw.

It is recommended that the vertical dimension of knuckles be fixed at 9 ins. as a minimum. The vertical dimensions of the knuckle have never previously been

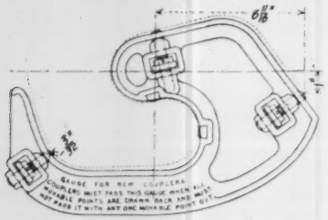


Fig. 2.—Proposed Gage for New M. C. B. Couplers Built to Proposed Contour Lines.

fixed. It is assumed to be 9 ins., but measurements show a minimum of 8½ ins. It is obvious that any decrease of this dimension renders separation more liable through variation in height of couplers.

It is recommended that the vertical dimension of the end of the guard arm be fixed at 7½ ins. as a minimum. The vertical dimension of the end of the guard arm is now indefinite; some are brought down more sharply than others, thus giving more chance for the couplers of a high and a low car to jump past each other.

plane, and the raised rib on the front of the gage prevents the coupler head from being displaced bodily up or down. The knuckle should stand ¼-in. above the top of this rib in a perfect coupler. Examinations made of all the prominent makes of couplers show instances of twist.

It is recommended that the horizontal plane containing the axis of the shank of the coupler bisect the vertical dimensions of the knuckle and end of guard arm. By the action of Congress the height of drawbar has been fixed at 34½ ins. maximum and 31½ ins. minimum. The line from which to measure has been determined by the Interstate Commerce Commission as the center line of the shank of couplers. It may, therefore, happen that a high car, with its center line of drawbar 34½ ins. above the rail, may have a head which is raised so that the knuckle extends 6 ins. above the center line and 3 ins. below, and to this may be coupled a low car, with the head of the coupler dropped so that the knuckle extends 6 ins. below the center line and 3 ins. above. In such a case the contact faces of the couplers in actual engagement are limited to one lug of each knuckle, and instead of being 6 ins., as intended by the law, they are reduced to 3 ins., and so are very liable to jump past each other on rough track.

It is recommended that the present gage for new knuckles, Fig. 4, be used on all knuckles purchased separately for renewals.

It is recommended that the vertical height of the stop shoulder, or horn of coupler, be not less than 3½ ins., and that the horn be arranged to touch the striking plate before the back of the head of the coupler strikes the ends of the draft timbers. There is now no uniformity in this dimension, and it is recommended simply to have it defined.

Contour Lines for Worn Couplers.—This takes in the subject of gages for worn couplers, and it is recommended that a twist gage for new couplers be used, so as to insure that the heads are neither twisted nor displaced sidewise in relation to the shank. The axes on which the M. C. B. contour lines are laid down are not referred to the axis of the shank of the coupler. As a result it may happen that the head of the coupler may be twisted with relation to the shank, so that the transverse axis or the vertical axis of the contour lines is not normal to the longitudinal axis of the coupler as a whole. It may also happen that the whole head of the coupler is displaced bodily to the right or left of the center line. To provide for these contingencies the gage shown in Fig. 3 is proposed. The body of the gage is the duplicate of the M. C. B. gage for new couplers provided with the long

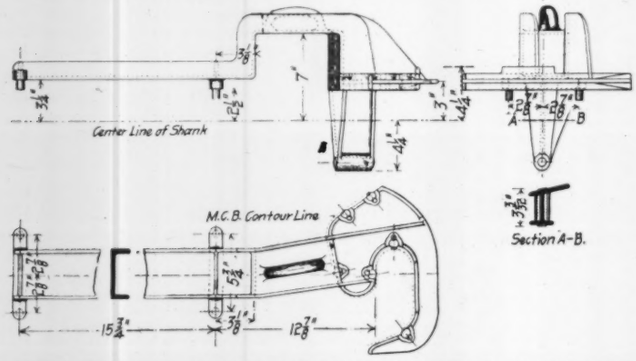


FIG. 3.—PROPOSED GAGE FOR DETERMINING TWIST IN M. C. B. COUPLERS.

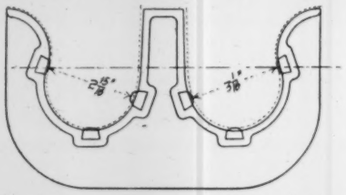


Fig. 4.—Gage for Determining Accuracy of Contour of New Knuckles for M. C. B. Couplers.

guard arm, and the contour is the same as the M. C. B. gage with all movable points drawn back. It is therefore sure to enter every coupler that has been properly inspected by the other gage. The arm extending back on the shank is provided with hardened steel pins, one pair of which must drop down over the square part of the shank immediately behind the head, and the other pair over the block upon which the yoke is riveted. There is sufficient play between these pairs of points to allow manufacturers proper variations, but badly distorted castings are discovered when the pins interfere with the proper seating of the gage. The arm extending downward insures that there shall be no twist in the riveted

mended that the gage shown in Fig. 5 be used. These gages are cheaply made of sheet metal stampings, and it is earnestly recommended that they be immediately put into use at all interchange points, and that the same care be given to the examination of couplers as is given to any other portion of the car. It is believed that this gage will put a stop to a large percentage of the instances of trains parting on the road without couplers unlocking.

Fig. 6 explains the distinctive features of the gage, which are to provide not only against dangerous wear in any one part, but also to provide for a combination of wear taking place all around the coupler. There are a good many points where wear can take place as shown by the following list: (1) Heel of knuckle, where the coupler comes in contact with the guard arm of the opposing coupler. (2) Inside of guard arm. (3) Inside face of knuckle where pulling stress is greatest. (4) Rear side of pivot pin hole in knuckle. (5) Front side of pivot pin hole in lugs of drawbar. (6) Pivot pin. (7) Locking surface of tail of knuckle. (8) Surface of lock in contact with knuckle. (9) Surface of lock in contact with drawbar. (10) Drawbar where lock comes in contact with it.

The common and final result of all this wear is so to diminish the effective width of the knuckle and so to increase the space between the guard arm and the point of the knuckle of the opposing coupler that the couplers can slip past each other. This the gage is designed to prevent by the action of the cam-shaped lever A. When this is pushed over to the end of its curved slot it throws all the slides part way out. Experience seems to indicate that the distance from guard arm to point of knuckle should not be greater than 5¼ ins., and this is the dimension used in the gage. It is easily seen that the gage would not pass through with any one slide fully out, and yet the couplers are dangerous. What comparatively small amounts of wear are permissible at the various points when this wear occurs simultaneously may be seen by the following figures: A departure from the original contour of 7-16-in. on the inside of the knuckle, ¼-in. on the point of the knuckle, 3-16-in. on the guard arm, and with the heel of the knuckle worn off 3-16-in. allows the couplers to take an unsafe position. It is easy to see from what precedes that members, for their own interests, should see that all couplers purchased should conform fully to the provisions in regard to gaging new couplers. If the gage passes with any movable point out the coupler should be rejected. A coupler which is ⅛-in. slack to gage is just the same as one that has been in service long enough to be worn off ⅝-in., so that by allowing slackness in the gage one is practically applying worn couplers. If a wear of ¾-in. on the inside face of knuckle is permissible, and is called 100%, then ⅛-in. slackness of the gage at that point represents 16% of the life of the coupler thrown away.

Specifications for Couplers.—It is believed that rigid specifications and tests will do much to weed out the poorer makes of couplers at present being furnished, and it is recommended that in the future all couplers be purchased subject to the provisions of the following standard specifications and tests:

After Sept. 1, 1899, all M. C. B. automatic car couplers purchased by or used in the construction of cars for the above-named company must meet the requirements of the following specifications:

Couplers shall be subject to the inspection of the representative of the above-named company as to their mechanical workings, general conditions, and tests.

The bars and knuckles must be fitted together in a workmanlike manner. Knuckles and locking pins or blocks must work freely and without any lost motion between knuckle and bar, or lock, which would permit the knuckle to drop forward beyond the proper contour line. But ¼ to ⅝-in. lost motion in the opposite direction is not undesirable.

The coupling or contact faces must be smooth and clean, free from grit, sand, scale, etc. The face to be square with axis of bar. All couplers must be free from surface defects. Couplers must conform to M. C. B. contour lines, dimensions and gages. They must couple and uncouple with each other (with either or both knuckles open) and with the master or sample coupler. They should unlock easily, and should lock with freedom when the knuckle is pushed in by hand. They must have complete locking fixtures.

They must have steel pivot pins 1½ or 1⅝ ins. in diameter, and of a uniform length of 13½ ins. from the under side of head to the center of pin hole for ⅝-in. cotter. Pivot pins, after being heated, and having the head struck up, must be carefully and properly annealed.

The hole for pivot pin in bar or knuckle should be drilled (or, if cored, must be drifted out) so as not to be more than 1-16-in. larger than the pin. The hole to be parallel with the face of the bar or knuckle and at right angles to the axis of the bar or knuckle.

Knuckles must conform closely to dimensions and fit neatly in coupler head, so that the contour will conform strictly to M. C. B. gages. They will not be accepted if distorted by improperly matched flasks or any other defects caused by molding, and must be free from shrinkage cracks, flaws and checks, and sand, scale or blow holes. The coupling pin must not be less than 1 9-16 ins. nor more than 1⅝ ins. in diameter, and must be parallel with the face of the knuckle and at right angles with the axis of the knuckle.

The name of the coupler and class of bar must be cast upon the top side of head of bar in letters and figures ⅜-in. long and raised 1-16-in. Each drawbar must also have the maker's mark and date of manufacture plainly cast or stamped upon it at some point where they will not wear off. Each knuckle must have the serial number of class or style and maker's mark either cast or stamped upon it at some point where it will not be worn off.

The weight of the coupler complete to be not less than .....lbs., and of bar without any of the attachments not less than.....lbs. The minimum weight of each knuckle to be.....lbs.

As many drawbars and knuckles as possible must be cast from each heat of steel or melt of iron used. All parts to be well annealed throughout.

Couplers and parts will be submitted to the following five distinct tests:

(1) Striking test on closed knuckles of complete coupler: Coupler to be held in machine so that the axis of the coupler is in the center line of drop, and the axis of the coupling pin hole passes through the center lines of the legs of the machine and the shank of the coupler rests solidly on the anvil. Blows to strike directly on knuckle: Three blows of 1,640 lbs. weight falling 5 ft.; three blows of 1,640 lbs. weight falling 10 ft.

A coupler will be considered as having failed to stand

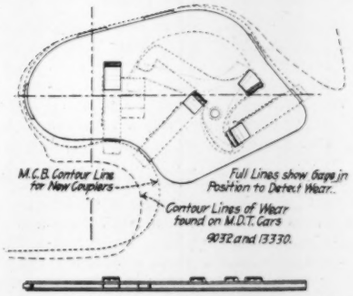

M.C.B. Contour Line for New Couplers
Full Lines show Gage in Position to Detect Wear.
Contour Lines of Wear found on M.D.T. Cars 9032 and 13330.

Fig. 5.—Proposed Gage for Determining Limit of Safe Wear in M. C. B. Couplers.

this test when it is broken before it has received three blows at 5 ft. and three blows at 10 ft., or when any cracks appear more than 1 in. long or open more than 1-16-in., or when the center line of the shank is distorted more than 1 in. from its original position, or when the knuckle is found to have closed more than ⅜-in. from its original position when pulled out against the lock after having received the three blows at 5 ft.

(2) Jerk test of complete couplers. Two couplers to be supported in the machine by the yoke forgings and draft springs provided. Blows to strike directly on the equalizer bar connecting the two couplers and resting on their

closed knuckles: Three blows of 1,640 lbs. weight falling 5 ft.; three blows of 1,640 lbs. weight falling 10 ft.

A coupler will be considered as having failed to stand this test when it is broken before it has received three blows at 5 ft. and three blows at 10 ft., or when any cracks appear more than 1 in. long or open more than 1-16-in., or when the knuckle has opened more than ½-in. from its original position or so that the equalizer bar will not stay in place when struck.

(3) Pulling test for complete couplers. Two couplers to be supported in the pulling machine by yoke forgings, to be locked together as in the running position, with their axes in the same straight line. Couplers to stand a steady pull of 120,000 lbs. if fitted with steel knuckle and 85,000 lbs. if fitted with wrought iron knuckle.

A coupler will be considered as having failed to stand this test when it is broken before it has been pulled the prescribed number of pounds, or when any cracks appear

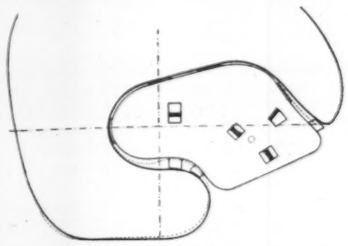


Fig. 6.—Diagram Showing Method of Detecting Danger from Combination of Wear in M. C. B. Couplers.

more than 1 in. long or open more than 1-16-in., or when the knuckle is found to have opened more than ¾-in. from its original position when pulled out against the lock, or when the couplers slip apart in the pulling machine.

In case of the failure of any part of the complete coupler under tests 1, 2 and 3, those parts which may not have failed may be submitted for a future test, providing such parts shall not be condemned by the individual tests hereinafter specified.

(4) Guard arm test of drawbar. Drawbar to be held vertically in machine so that the edge of guard arm is in the line connecting the centers of the legs of the machine, and so that the shank rests solidly on the anvil. Blows to strike directly on the edge of the guard arm; for malleable iron couplers, three blows of 1,640 lbs. weight falling 3 ft.; two blows of 1,640 lbs. weight falling 5 ft. For steel couplers, three blows of 1,640 lbs. weight falling 3 ft.; four blows of 1,640 lbs. weight falling 5 ft.

A drawbar will be considered as having failed to stand this test when it is broken before it has received the prescribed number of blows, or when any cracks appear more than 1 in. long or open more than 1-16-in., or when the center line of shank is distorted more than 1 in. from its original position, or when the head is distorted sufficiently to allow the hammer to hit on the face of the bar, or the lugs of the bar to strike against the hammer.

(5) Separate knuckle test. Knuckle to be laid horizontally on one of its lugs, upon a solid anvil, and given the following blows upon the top of one lug: Knuckles pivoted 2 ins. or less from center of pivot pin hole to face of knuckle to stand three blows of 1,640 lbs. weight falling 3 ft.; one blow of 1,640 lbs. weight falling 4 ft. Knuckle pivoted 3 ins or less from center of pivot pin hole to face of knuckle to stand three blows of 1,640 lbs. weight falling 3 ft.; two blows of 1,640 lbs. weight falling 4 ft. Knuckles pivoted over 3 ins. from center of pivot pin hole to face of knuckle to stand three blows of 1,640 lbs. weight falling 3 ft.; three blows of 1,640 lbs. weight falling 4 ft.

A knuckle will be considered as having failed to stand this test when it is broken before receiving the proper number of blows, or when any cracks appear more than 1 in. long or open more than 1-16-in.

At the end of all the above tests, except No. 5, couplers will be tried for disablement. Knuckles must open and locking devices be operative after the coupler has received the specified test. Before testing, couplers must have a row of center-punch marks put upon the center line of top of shanks, so distortion can be detected.

Couplers will be chosen for test as follows: One complete coupler shall be taken at random by the inspector from each lot of 100 couplers offered for test. The pivot pin and locking parts may be returned to the manufacturer. The knuckle will be tested as in test No. 5 and the drawbar will be subjected to the guard arm test as in No. 4. If the test part fails to stand the prescribed test, a second coupler will be taken from the same lot from which the first test part was taken, and if it stands the test and if at the same time the first part tested has attained an average of 75% on the basis of 100% as meeting the full requirements, then the lot will be accepted; but if the second part fails to stand the test, then the lot will be rejected. For each 1,000 couplers offered, or fraction order, five complete couplers shall be taken at random by the inspector. One shall be submitted to the striking test, No. 1; two to the jerk test, No. 2, and two to the pulling test, No. 3. If any coupler should fail to stand the prescribed test, another coupler or pair of couplers will be taken from the same lot from which the first test couplers were taken, and if it stands the test, and if at the same time the first tested has attained an average of 75% on the basis of 100% as meeting the full requirements, then the lot will be accepted; but if the second coupler fails to stand the test, then the lot will be rejected.

All drop tests shall be made on an M. C. B. standard drop testing machine, Fig. 7. The bar to be held firmly in machine with all iron blocks and wedges sledged down tight. Couplers and knuckles will be tested and inspected preferably at the works where they are made. Manufacturers must furnish, free of cost, test couplers, testing apparatus and assistance necessary to make satisfactory tests and inspection.

In addition to these matters pertaining strictly to its subject, the attention of the committee has been called to the fact that in some cases couplers with shanks of dimensions differing from the standards of the association

WEATHER TABLE FOR MAY, 1899. (Furnished to Engineering News by the Department of Agriculture.)

	Stations.	Temperature. (Degrees Fahrenheit.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Max.	Direction at time of max. velocity.	Precipitation—Rain or melted snow. (Inches.) Total.	Heaviest in 24 hours.	No. of rainy days.
Northern Cities.	Northfield, Vt.	52.6	81	26	55	9.1	50	SW	1.52	0.28	11
	Portland, Me.	54.1	84	36	48	8.0	30	NW	0.73	0.29	8
	New York City	61.0	84	46	38	12.2	46	SW	1.14	0.54	8
	Pittsburg, Pa.	65.0	86	42	44	5.3	35	NW	3.56	1.52	11
	Chicago, Ill.	59.0	83	42	41	17.2	56	S	4.35	0.92	15
	Omaha, Neb.	62.3	87	44	43	9.7	32	SW	4.45	1.33	14
	St. Paul, Minn.	58.2	82	37	45	9.0	33	NW	3.50	1.55	13
	Duluth, Minn.	46.6	72	33	39	11.8	38	NE	4.66	1.15	13
	Bismarck, N. Dak.	52.3	84	27	57	12.3	48	W	4.27	1.65	16
	Average.	56.8	83	37	46	10.5	42	—	3.10	1.03	12
Southern Cities.	Washington, D. C.	64.4	90	42	48	5.8	36	SW	2.53	0.76	14
	Louisville, Ky.	69.0	90	49	41	8.0	31	SW	3.17	0.81	14
	St. Louis, Mo.	68.6	90	48	42	9.0	48	SW	6.32	1.58	15
	Savannah, Ga.	76.4	97	58	39	8.6	42	NW	1.11	0.41	8
	Kansas City, Mo.	67.6	86	49	37	9.6	32	NW	5.10	2.14	10
	Jacksonville, Fla.	78.3	96	61	35	7.6	48	W	1.86	0.99	7
	Chattanooga, Tenn.	73.2	92	56	36	6.3	37	W	1.73	0.40	10
	New Orleans, La.	78.8	90	65	25	7.6	26	SW	0.14	0.14	1
	Memphis, Tenn.	73.7	90	58	32	9.4	42	W	5.18	1.31	10
	Palestine, Tex.	76.6	91	63	28	8.0	28	S	4.84	4.20	6
	Average.	72.7	91	55	36	8.0	37	—	3.20	1.28	10
Western Cities.	Helena, Mont.	47.2	76	24	52	9.0	38	SW	1.98	0.44	12
	Port Crescent, Wash.	46.0	70	31	39	4.8	20	W	2.15	0.53	20
	San Francisco, Cal.	52.6	80	43	37	13.9	37	W	0.86	0.77	2
	Salt Lake City, Utah.	52.6	83	25	58	6.8	36	W	2.59	0.72	10
	Santa Fe, N. Mex.	55.6	79	24	55	8.5	42	SW	0.01	0.01	1
	Denver, Colo.	56.8	83	29	54	8.6	42	W	0.15	0.06	5
	Yuma, Ariz.	—	—	—	—	—	—	—	—	—	—
	Average.	51.8	78	29	49	8.6	38	—	1.29	0.42	8

are being made and introduced in service. As this change will affect the standards of the association and work possible hardship to other railways in the way of interchange

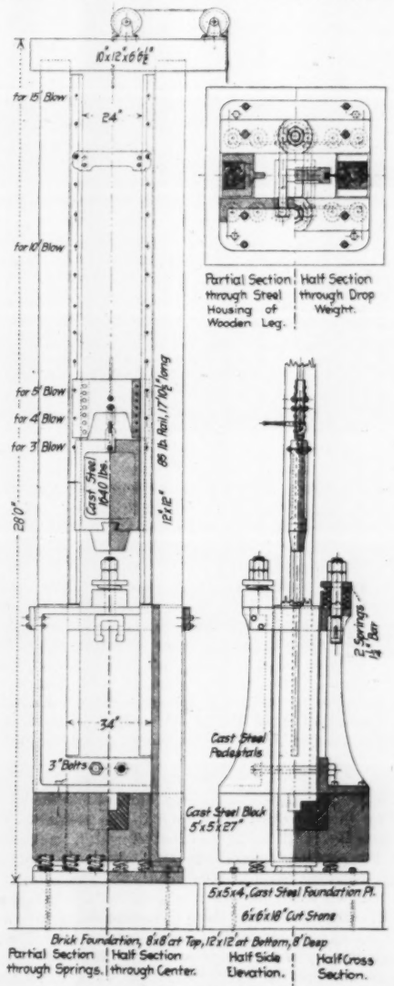


Fig. 7.—Proposed Drop Test Machine for Testing M. C. B. Couplers.

of cars, it calls the attention of the association to this, with a view that the subject of increased dimensions of the shank be referred to a committee for further investigation, and report what changes, if any, should, in their judgment, be made in present standards of the association. It is also suggested that the back corners of the yoke in the pocket attachment be changed from ⅛-in. radius to ⅝-in. radius. It is further suggested that the play of the shank of the coupler in the carry iron be not less than ½-in. on each side.

Another matter which has claimed considerable attention is a standing committee on couplers. It is recommended that such a committee be appointed, whose duty it shall be to test couplers submitted to them. A standing committee on coupler tests has been suggested from time to time, somewhat after the manner of the Standing Committee on Triple Valve Tests, and Brake-Shoe Tests. There ought to be some way of certifying the proper design and quality of so important an appliance as a coupler, and this committee would prove a very valuable addition to the others.

In conclusion, the situation in regard to the multiplicity of couplers and parts is brought to the serious attention of the association. There should be some way of reducing the present uselessly extravagant manner in which repair parts for the 27 different kinds of couplers with their 93 different knuckles have to be carried at the hundreds of interchange and repair points throughout the country. For this reason it is recommended that pivot pins should be of one uniform length and of only two sizes. A pivot pin 1½ ins. in diameter is small enough for use in a coupler, and by making one length sufficient for the coupler having the greatest distance over the lugs, it can easily be put into any coupler in which this distance is less. This multiplicity of repair parts should be done away with, and by a process of evolution, a few standard couplers should be retained, and these gradually introduced throughout the country as breakages make replacements necessary.

The construction of a standard drop testing machine has long been urged, and the accompanying drawings, Fig 7, are submitted as embodying a satisfactory design. In the first place, the machine must be reproducible. A machine built on rock foundation should give just the same results as one built on soft soil. To this end it has seemed indispensable that the anvil should be spring supported. As strong and rigid a foundation as can be built must be put down, and the capstone covered with a cast-steel bed plate, having recesses cored in it to receive the steel housings for the legs of the machine. The 15-ft. blows will be abandoned, as all the testing necessary can be done with the 10-ft. blows, and the 15-ft. blows have been found to be too destructive to the auxiliary apparatus in jerk tests, yoke forgings and equalizer bars breaking when submitted to these severe shocks. Besides that, it seems to be difficult to get couplers to stand even 10-ft. blows, so that 15-ft. blows may be left out of the question entirely. The anvil is made heavy enough to absorb in itself all blows and is supported on springs which are wound on definite sizes of mandrels, and from steel to fulfill definite specifications. The uprights to support the brackets carrying the yoke attachment for jerk test are bolted down to the anvil, and leave plenty of room for the latter to rise and fall easily. The machine is accessible in the highest degree, and couplers can be easily and quickly put in and taken out in all tests. By the use of steel blocking and wedges, all couplers are held firmly in drop tests, and all are put on the same basis. It is believed that this machine can be built anywhere, and couplers tested on it are sure of receiving the same treatment as others tested in a different place.

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Public interest in that ancient bore, the North River tunnel, has been moderately aroused by its sale under foreclosure proceedings to the representatives of the bondholders who advanced the money which was spent in a spasmodic revival of the work in 1890. Perhaps there may be found other credulous persons with surplus funds to dispose of who may furnish the wherewithal for another try at this enterprise; but it does not seem likely. Some of the engineering difficulties in connection with this work were reviewed in our issue of June 16, 1892, when we showed that the stability of the completed portion of the tunnel was at least open to question. There seems to be a general impression that the enterprise was carried somewhere near completion before its abandonment, eight years ago; but as a matter of fact, out of some 27,000 ft. of tunneling necessary for the construction of a double track tunnel line and approaches, only about 4,600 ft. has been completed. Doubtless the work would have been carried through long ago, notwithstanding the engineering difficulties, were it not for the great doubt as to whether the tunnel can secure a paying traffic when completed; and this doubt is likely to prove a serious obstacle to the success of further attempts to raise funds for the work.

To the cursory observer, unfamiliar with local conditions, it may seem strange that such a tunnel as that proposed under the Hudson River could not, as a matter of course, command traffic enough to make it pay. Here is an enormous traffic that is now carried across the river by means of car floats. The Grand Trunk railway, a few years ago, displaced its car float system of transfer by a tunnel under the St. Clair River, and it has proved a good investment. Then why should not a tunnel under the Hudson River be many times as profitable?

It is arguments like this, plausible enough on their face, that the tunnel promoters will rely upon in their search for funds; but such arguments will not bear investigation. The St. Clair tunnel, for example, terminates in an open field, where there was ample room for an extended system of terminal yards. The Hudson River tunnel would land on the New York side in the heart of one of the most densely crowded cities on the face of the earth, where every square foot of area has to be carpeted with money to effect its purchase. There is no room for switching yards on Manhattan Island, and without ample terminal yards it would be impossible to make use of the proposed tunnel for freight traffic. The actual fact is, as we have before pointed out, that the North River is a cheaper car distributing yard than any that could be built on land on either shore, and while the clumsy car-float and its attendant tug may seem a crude way of transferring freight across the river, freight can be moved better and more cheaply in this way than it could be by either a tunnel or a bridge.

As for the passenger traffic, the probabilities are very strong that passengers will prefer a ride across the river on a modern ferry-boat to a three-mile ride through a tunnel beneath it. There is a fighting chance that such a tunnel might be so planned as to accommodate some suburban traffic; but it would have to handle a very great amount to make it profitable.

To any one who may think that there is little for army engineers to do after active military operations are over, we commend the notes on the work actually performed in Cuba by two of the Regiments of U. S. Volunteer Engineers, published elsewhere in this issue. It is true that the bulk of this work is really civil engineering rather than military engineering, using the former term in its old sense, yet it was none the less work essential to be done for the better and safer military control of the territory occupied. Good roads and reliable maps of the country about them, a pure and abundant water supply, the sanitation of buildings and towns occupied by troops are even more necessary to armies than to peaceful communities; for when men are massed, as they are in camps, fewer ordinary precautions are possible, the conditions are usually present for the rapid spread of disease, and in the case of Cuba these conditions were peculiarly unsanitary. As a matter of fact there is more for the engineer to do after the war is over—in such a country—than during its active conduct. In the latter case he is called upon to hastily reconstruct destroyed bridges and to otherwise provide for the better transit of armies; he superintends the construction of offensive or defensive works; makes rapid surveys of the country traversed, and in a manner guides the movement of troops. But while the actual fighting is going on the engineer has little time or opportunity to do anything that tends to the greater comfort or safety of the living; he expends his force in the direction of destroying life and property and does little to save it. But with the enemy conquered, the engineer then commences his true work—that of building up and improving upon past conditions, as these result from the destructive agencies of war, or are due to centuries of ignorance and official corruption or neglect. What can be done in this connection is well shown in the article referred to; and the case of Cienfuegos is only one exhibit of the direct and beneficial result of the labors of the engineer in the field of sanitation. Commencing with a weekly death rate of 138, at the time of occupation by the American troops, this was reduced to 73 by the distribution of food to the famished inhabitants, and to 29 by the thorough cleansing of the streets, courtyards and cesspools; and as the decrease was steady and the time elapsing short, we may look for a greater improvement still. Gen. Wood has done the same thing for Santiago; and under Gen. Ludlow and Major Black, both officers of the Engineer Corps, Havana is in a much better sanitary condition at the present time than ever before. It is for these reasons that we repeat that the best work of the military engineer is in the direction of healing the scars left by war, and in preparing the conquered territory for the labors of the civil engineer—properly so called—with his railways and highways and the permanent improvement of cities and towns and all that belongs to them.

Mr. Edward Atkinson, of Boston, has written many good things and some not so good; among the former is a paragraph in a circular (No. 74) just issued by the Boston Manufacturers' Mutual Fire Insurance Co., and entitled, "Mill Construction: Sometimes called Slow-Burning Construction." We copy this paragraph as follows:

> It will be observed that owners and occupants are the only persons who can in any manner insure property against loss or damage by fire. All that underwriters can do is to give them the best advice in their power, and to give them contracts of indemnity for payment of unavoidable losses. Loss by fire in any considerable measure is usually the fault of the owner or occupant of the property insured or destroyed.

We commend this idea to the thoughtful consideration of manufacturers and owners of buildings, and to the engineers and architects whom they entrust with their work. If it were more generally realized that the insurance of property against fire can only be done through the intelligent planning and constructing of the building and its equipment, and in its care and supervision when it is put into use, a large part of the present annual fire loss would be avoided.

THE MASTER CAR BUILDERS' COUPLER.

The Master Car Builders' standard automatic coupler is now in use on over a million freight cars in the United States, and after Jan. 1 next will be the only coupler used on cars running in general freight car interchange. Had the reasonable expectations of its friends and advocates been realized, the old-time troubles with draft apparatus should be vastly reduced. It is unfortunately true that this is not the case, and that the new coupler, as it is now in service, is proving a mine of trouble to the railway companies in a variety of ways.

So serious and annoying are these troubles that a few railway officials have for some years urged, and still continue to urge, that the whole M. C. B. type should be abandoned, and the railways of the country should start out anew to find and adopt and equip their cars with an automatic coupler of some other type. We need hardly say, however, that there is no prospect whatever of this. The railways are not at all likely to begin all over again the work of getting a satisfactory automatic car coupler, and send their investment of $15,000,000, more or less, in M. C. B. couplers to the scrap-heap. Besides this, it has never yet been shown that the "vertical plane" type of automatic coupler is not on the whole the best that could be devised for freight-car service, or that any other automatic coupler ever devised would not be the cause, on the whole, of more troubles than the present M. C. B. coupler.

Nevertheless there is nothing to be gained by covering up or overlooking the serious defects which the M. C. B. coupler has developed in operation. Let us see, if we can, how these defects have arisen, and what may be done to remedy them.

The present Master Car Builders type of coupler, as some of our readers may remember, was adopted as the standard of that association in 1887. It had been under consideration for at least five years previous, and a large amount of experimental work and study had been given to the problem before the final action. With this investigation before it as a basis, the association fixed upon the "vertical plane" type of the Janney pattern as that promising the greatest measure of practical success, and adopted standard contour lines defining the form of the engaging hooks of the coupler, leaving manufacturers, however, to vary every other part of the coupler as much as they chose. Looking back now, it can be seen that a large part of the troubles which have been experienced have been due to the wide opportunity for variation which was then left open; nevertheless it is not certain that any more definite action would have been prudent at that time with the limited experience then available; and it certainly was not possible to secure it under the conditions which then existed.

At the time this action was taken there was only

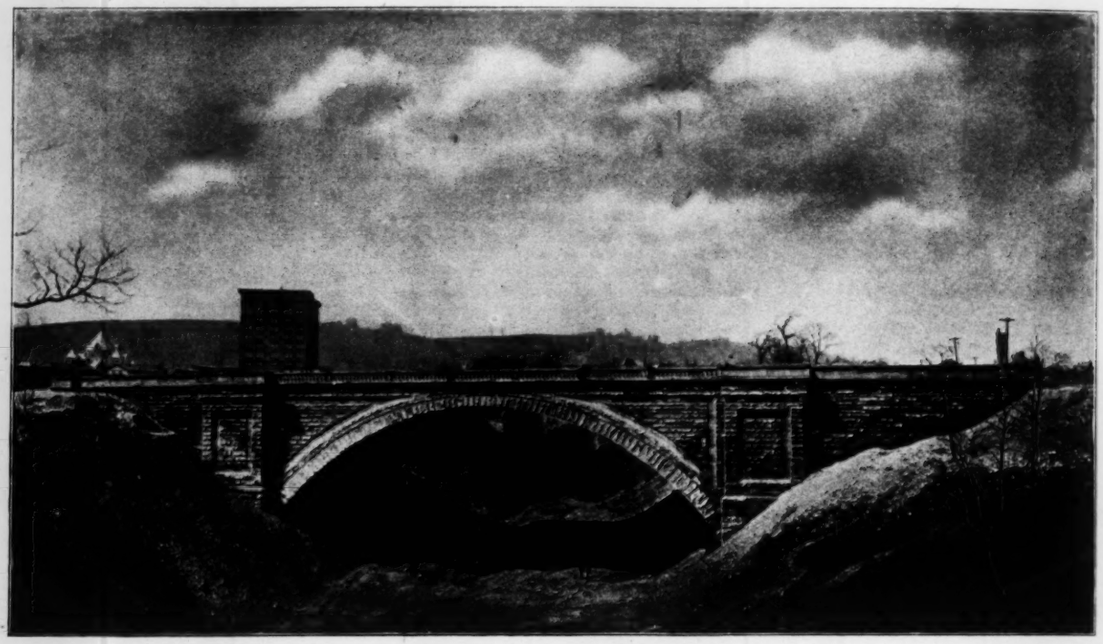


FIG. 1.—GENERAL VIEW OF COMPLETED BRIDGE.

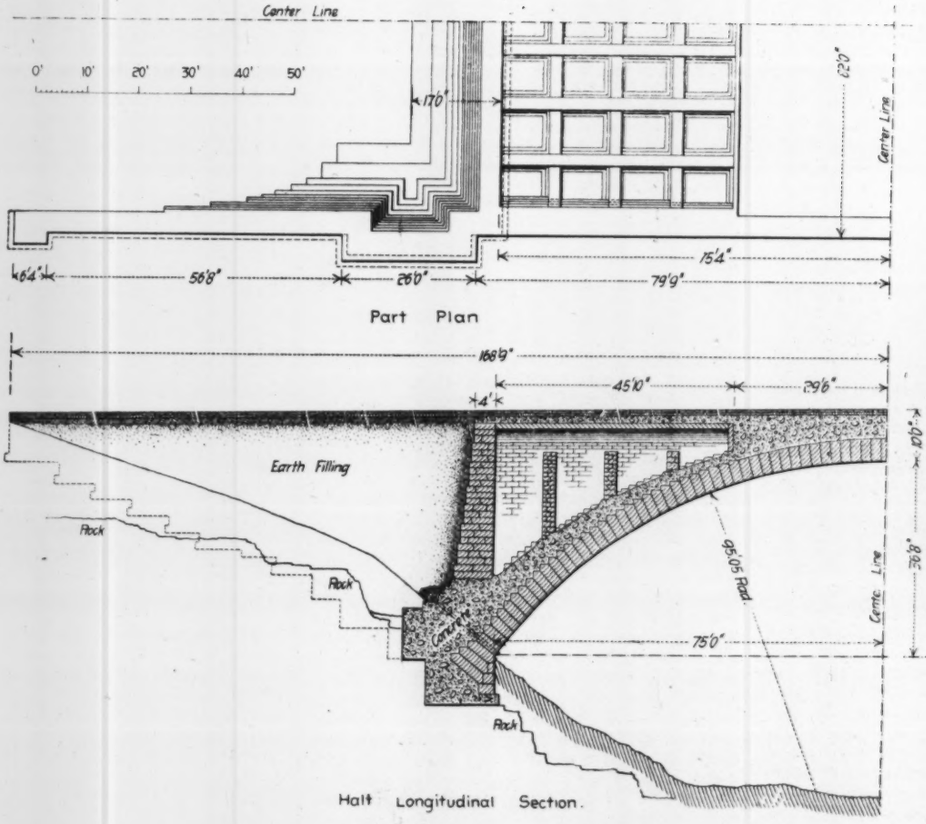


FIG. 2.—PART PLAN AND HALF LONGITUDINAL SECTION.

FIG. 3.—VIEW

FIG. 5.—S

(Showing the extrados

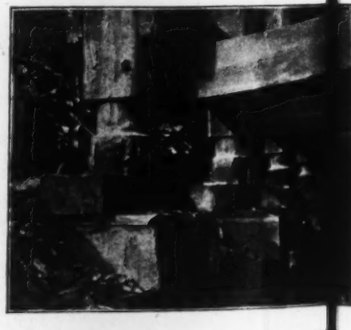
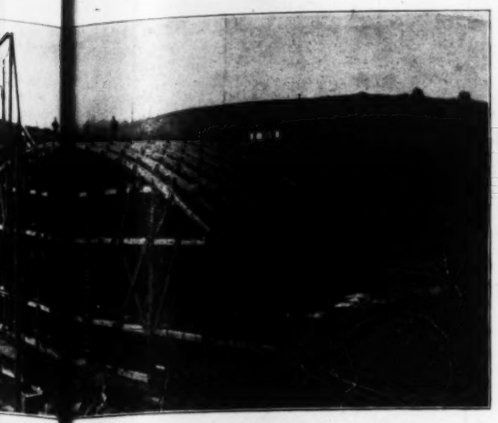


FIG. 4.—VIEW OF SAND CYLINDERS FO
LOWERING CENTERS.



3.—VIEW OF FALSEWORKS BEFORE PLACING LAGGING.

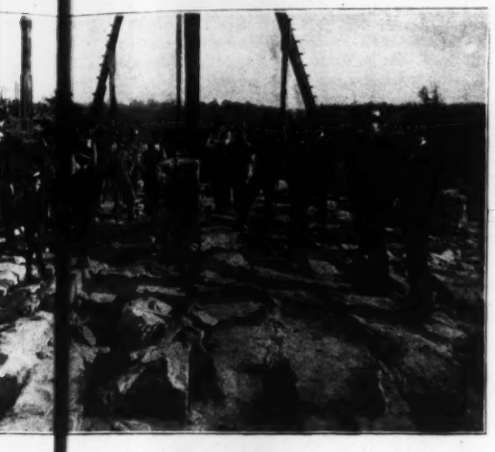


FIG. 5.—SETTING THE LAST KEYSTONE.

(The extrados the sheeting purposely left as rough as possible to bond with the concrete backing.)

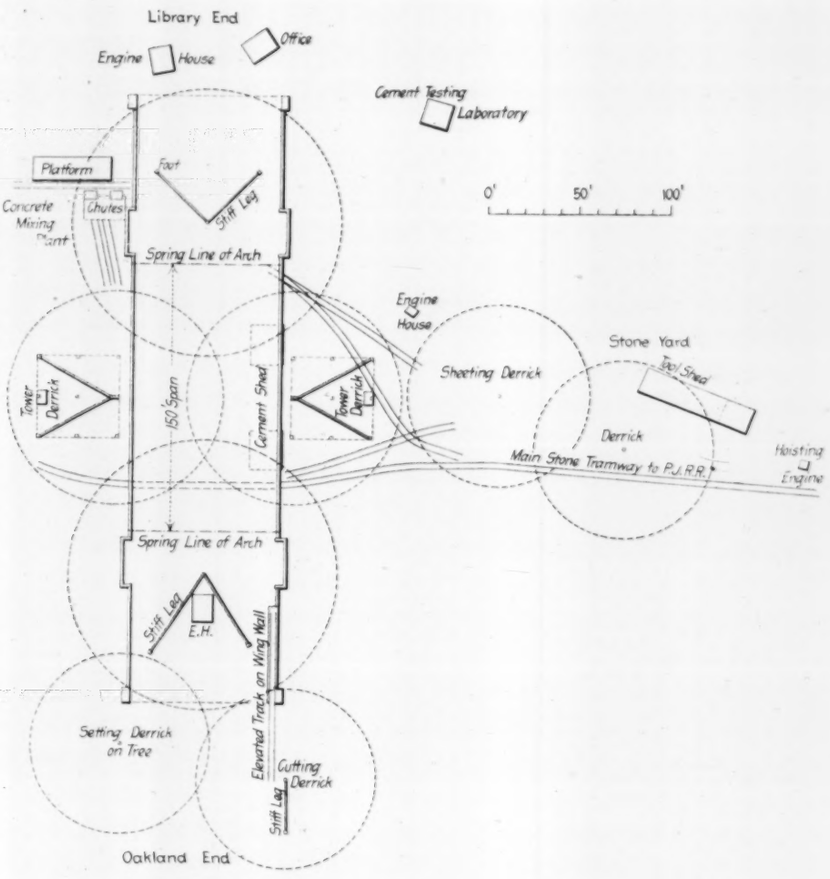


FIG. 6.—PLAN OF DERRICKS AND TRACKS FOR HANDLING MATERIAL.

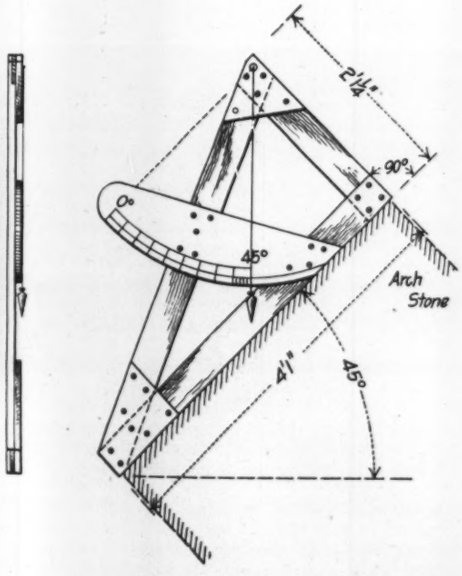


FIG. 7.—GRADUATED FRAME FOR SETTING ARCH STONES

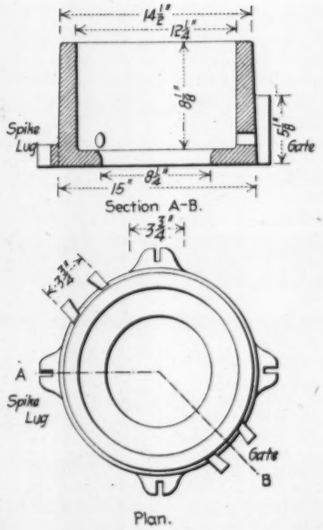


FIG. 8.—DETAILS OF SAND-BOX.

THE BELLEFIELD ARCH BRIDGE AT THE ENTRANCE TO SCHENLEY PARK, PITTSBURG, PA.

Henry B. Rust, M. Am. Soc. C. E., Chief Engineer.

Neeld & Foley, Pittsburg, Pa., Contractors.

one manufacturer making couplers on these lines. It was not long, however, before others came into the field, and each one sought to devise some variation from the couplers already on the market which he could make use of to advertise his goods. The result is that to-day there are nearly a hundred different forms of M. C. B. couplers on the market. With the increase in the number of different couplers there have grown up variations from the original contour lines, as well as from the details which were not standardized, and to-day there are very few couplers in the market which conform exactly to the standard. It is needless to say that with this rapid increase of rival designs and rival manufacturers, competition has become very sharp, and in many cases quality has been sacrified to price.

The train of evils resulting from these conditions has grown to be a very long one. It is easy enough to see now how this could happen. The multiplicity of designs, which we have noted, means in itself a host of difficulties. Consider for example the specific case of knuckle breakages. At present, knuckles break more frequently than any other part of the coupler. It is worth while to notice here that one important reason for this is that at present the knuckle must be weakened by an opening in the middle to permit it to be coupled with the old link and pin coupler. It should be understood that this weakness, which is often held up as a defect of the M. C. B. coupler, is directly due to imposing a duty upon it which it will not be called upon to perform when the link and pin draw bar is abolished entirely. To return to our example, however, it appears that the craze for variations has been carried so far that out of the hundred or more knuckles in use only two or three will interchange with each other from draw bar to draw bar. This means obviously that every railway must carry in stock knuckles to fit every coupler which is likely to come onto its lines in interchange traffic, or else have a car delayed on its track until the knuckle can be procured from the maker, or until the entire coupler can be removed and a new one put in place. It is plain, moreover, that what is true of knuckles is true of many other coupler parts. Thus it comes about that the railways are to-day burdened at every repair point with stocks of couplers and parts of couplers of every conceivable type, which they are compelled to keep on hand so that they may be able to repair their neighbors' cars properly and keep traffic moving.

The expense of carrying this burden of different repair parts is not, however, the only trouble for which the multiplication of coupler designs is responsible. It has been largely the cause of bringing about the variation from the original Master Car Builders' contour lines. To see how general this deviation from the original standard contour has become, we have only to refer to the report of the committee on M. C. B. couplers, which was presented last week at the convention of the association at Old Point Comfort. This committee stated that it had found greater or less deviation from the standard in every coupler examined by it, and its investigations had comprised all the leading makes of couplers.

The very serious objections to practices of this sort will be apparent to every engineer. Two couplers which engage with each other are really two parts of a single machine through which stresses of many tons are transmitted. Manifestly these two engaging parts should have a definite and fixed form in relation to each other. To expect good results when these forms are varied by every manufacturer to suit his own ideas is about as foolish as to expect satisfaction if makers of bolts and nuts for the general market should follow no standards for the pitch, shape of threads and size of stock. In the M. C. B. coupler, the area of bearing surface available for wear and the trueness of the pull upon the coupler knuckle and shank depend upon the contour lines of the two couplers, which are engaged, being duplicates. With the present variation in the contours of different couplers, uniform bearing is impossible to secure, even when the different couplers are new and properly applied to the cars. It is hardly necessary to point out that uneven wear means rapid wear and eccentric strains on the coupler head and draw bar. The life of the coupler is shortened and its strength and safety are materially decreased.

It is hardly necessary, we think, to enlarge further upon the evils which result from deviations from uniform contour lines. If anyone questions their importance let him study for a few moments those extreme examples of misfitting couplers due to the distorted or twisted position of the head in relation to the shank. What is true of these is also true in a lesser degree of minor variations in the fitting of the bearing parts. While we are on the subject it may be well to point out that this distortion, either vertically or horizontally, of the coupler head in relation to the axis of the shank, is a very common fault. Thousands of such couplers are running on American railways to-day. Experience has shown that often a very small amount of wear coupled with the distortion of the bearing parts due to the twisting will enable these couplers to slip by each other and cause a break-in-two of the train. The opposite condition of binding also frequently occurs, and in passing sharp curves the coupler head breaks off or the car is derailed.

The present defects in the manufacture of couplers, however, do not all lie in faulty foundry work. Defective design and the use of inferior material are faults which are quite as prominent The use of defective material in couplers employed in interchange traffic is something about which the committees of the various railway clubs and other technical organizations have been very chary in expressing themselves, but such couplers are, nevertheless, used, and are often used dishonestly. There are few railway men who will deny that there is more than one railway to-day which makes a practice of buying the cheapest couplers in the market and keeping them at repair points for use in replacements. It is by no means beyond belief either that many of these replacements take place without there being a defect in the original coupler to warrant it, especially when the latter coupler happens to be one of the $8 kind. This is not a gratifying commentary to make upon the rectitude of some of our high railway officials, but those who are well informed agree that it is in some cases a true one. As matters stand now, moreover, cars with these couplers may travel over any railway in the country and cause wrecks by their failure, for which the railway which suffers the loss can obtain no redress. It is familiar knowledge to every motive power official that couplers are being used every day whose inferior quality make them a constant menace to safe train operation.

The foregoing summary of some of the chief troubles which have grown up about the M. C. B. coupler has necessarily been brief, but it indicates pretty clearly, we think, where the source of these troubles lie. We believe that no fair-minded person can maintain that it lies in any fundamental deficiency in the design and principle of the device. On the contrary, it seems to show clearly that it is an excellent device for its purpose, and is giving marvelously good results under conditions which are extremely adverse to such results being obtained. What has been said appears to us to show further that the railway companies themselves are largely responsible for the evils which have fallen upon them. The question before us, however, is not who should shoulder the blame, but how are we to remedy the trouble which has befallen us?

On the whole, we think that the course adopted by the Master Car Builders' Association at its convention last week, and which is outlined in our report of the convention proceedings in this issue, is, perhaps, the wisest one. This was to adopt rigid specifications, requirements and tests, and to throw all the influence of the association to bear to see that these are lived up to. Ultimately the association may very reasonably see fit to go a step further, when its standing committee on coupler tests has weeded out the defective couplers now on the market, and give railways the right, in its rules of interchange, to refuse to accept as proper repairs all replacements made with couplers which have not passed the tests, and been accepted as satisfactory. It may ultimately go further still, and refuse to accept any cars whatever with couplers not approved as safe and proper by the Association's Committee.

Had it taken some such action as this four or five years ago, it would have saved millions of dollars to the railway companies of the country and much wear and tear of spirit to railway officers. Doubtless some such action would have been taken, or the still more radical action of adopting a standard specification for every part and detail of the M. C. B. coupler, and compelling its use on all cars used in general interchange; but it is clearly recognized that the power of the Association, as a whole, to coerce the action of its members is quite limited. The present interchange system is, in fact, but a makeshift, and eventually some form of joint ownership and control of all freight cars used in general interchange will have to replace it. Until that reform is brought about, a good many defects in the conduct of freight car construction, repair and operation must be endured as well as may be, and partial remedies must be accepted as the best available.

LETTERS TO THE EDITOR.

Union Railway Station at Omaha.

Sir: I have read with much interest the article on this station in your issue of June 1. Regarding the location of the lunch room, the criticism is well made. Some of the railway managers who have had a large experience with lunch rooms and the traveling public in Nebraska and in the Southwest could not be induced to place a lunch room in direct communication with the waiting rooms. I think this is largely on account of the multitude of flies, which it seems almost impossible to guard against. The removal of the lunch room was entirely for the comfort of the public occupying the waiting rooms.

Another criticism is in regard to direct outlet from trains. This, however, has been provided for at this station. We have a wide, direct staircase from the trainshed to the viaduct, of which fact I think you were not informed. We also have a direct outlet and entrance to the trains on the lower level, between the buildings. These are very important points in station design.

Yours very truly,
Charles S. Frost,
Frost & Granger,
Architects.

Chicago, June 16, 1899.

Bids Wanted for Professional Services.

Sir: Some of your readers who are out of a job may be interested in the following letter which was recently received by me, and I ask that you give it publicity so that if any of them wish to enter into the competition for furnishing professional services at the lowest price he may do so. Undoubtedly the city of Marietta will give the job to the lowest bidder:

Marietta, Ohio, June 12, 1899.

Gentlemen:

We are expecting to build a new bridge in our city. By return mail make us proposition of the work as follows:

To take soundings (borings is necessary), prepare plans and specifications for steel bridge across Muskingum River in city of Marietta, Ohio, both sub and superstructure. Said bridge to be as follows: Length about 765 ft., one swing draw span, two stationary spans, one approach, width of driveway 32 ft., two 6-ft. sidewalks. Driveway to have a capacity of 100 lbs. per square foot, sidewalk 80 lbs. per square foot. Total cost of bridge to be between seventy and ninety thousand dollars.

Make proposition on above, then proposition on taking charge of said work as inspectors, to do both mill and shop inspection, superintend the erection of both sub and superstructure, test cement, and, in short, all detail work connected with above structure. Make us proposition for both together, drawing plans and specifications and superintend structure as above.

If you are not prepared to take up the entire work you may bid on such portion as comes in your line.

Please state what time will be required to furnish plans and specifications if proposition is accepted by us.

Respectfully yours,
J. P. Marsch, Chairman Bridge Com.

I might perhaps put in a bid for the above work myself except for certain physical infirmities, and while you are about it would you just as lief insert the following card:

To All Physicians.

I have a bad case of piles, complicated with diseased lungs and incipient paresis. By return mail will you please send me a proposition as follows:

To take soundings (borings if necessary) of my lungs, diagnose the rest of my ailments and prepare plans, specifications and prescriptions for treating me.

Then make a proposition for taking entire charge of the case and curing me.

If you are not prepared to treat all of the above diseases you may bid on such portion as comes in your line.

Please state time required to furnish diagnosis, plans,

specifications and prescriptions, also time required to effect a cure if your proposition is accepted.

The right is reserved to reject any or all bids.

Yours truly,

Chas. F. Stowell.

Albany, N. Y., June 15, 1899.

(Our correspondent betrays no symptoms of paresis in his letter.—Ed.)

Interoceanic Canal Routes.

Sir: I have read with interest your article on "The Appointment of a Commission to Investigate Isthmian Canal Routes," in your issue of March 23, 1899, and as money has now been appropriated for another and very extensive investigation, the subject becomes one of public as well as engineering interest. I should like briefly to compare the following five routes which have been proposed for the canal: (1) Panama; (2) Nicaragua; (3) San Blas; (4) Karweise; (5) Darien. The comparison is based on various published reports, and I will confine it to the following five points: (1) Harbors; (2) distance; (3) summit level; (4) climate; (5) rivers and lakes.

We will first consider these five points in regard to the Nicaragua Canal route. Commander Selfridge, U. S. N., in his report, states that it is entirely destitute of harbors, and I also find that the sea ports of Greytown and Brito will require costly and extensive improvements in the way of excavation, piers, jetties, breakwaters, etc. The total length is a little more than 194 miles, or 169 miles by an alternative route. The summit level is given variously as 80 to 120 ft. The climate along the San Juan River is said to be one of the most unhealthful in Central America. The San Juan River is from 2 to 20 ft. deep and navigation is rendered difficult by rapids, though small steamers have ascended its whole course. The mouth of the river has shifted more than once. Lake Nicaragua is said to be a dangerous sheet of water, subject to water spouts and violent storms.

Now let us take the Panama route. It has been stated that the harbor of Aspinwall is so indifferent that during the season of the "northers" ships are frequently obliged to put to sea. At Panama there is not water enough at low tide to float large vessels within 2½ miles of the town. The length is about 45 miles and the summit level is about 68 ft., according to the latest project, the altitude of the divide being over 300 ft. As to climate, the Isthmus and its towns are said to be hotbeds of disease. The proposed route crosses the Rio Grande River 13 times and the Chagres River 78 times. This latter river is said to be capable of rising 30 ft. in a few hours, and ever since the Panama Canal was projected the crossing of the Chagres River and the great Culebra cut have been recognized as very serious problems. There are no lakes, or none worth mentioning.

The San Blas route is conceded to be the shortest across the isthmus, but a tunnel five miles in length would be required. This route is proposed for a sea-level canal, and possesses two good features: (1) magnificent harbors afforded by the gulfs of San Blas and San Miguel, and (2) the short distance of 30 miles in a direct line. Dr. Cullen, however, speaks of the disadvantage of a bad coast for this route, and, in any case, the above good features would compensate but slightly for the enormous disadvantages. The mountain range which it would cross is said by Dr. Cullen to have an elevation of from 2,000 to 6,000 ft. There is reason to suppose that the climate compares favorably with the other parts of the Isthmus. The rivers and lakes are of little importance to the project.

We now come to the route proposed by Mr. Gustavus A. Karweise, C. E., a description of which appeared in Engineering News, March 14, 1895. This is said to have 11 miles of free navigation up the Bay of San Miguel and Tuyra River, but he proposed a tunnel 11,880 ft. long. The total distance from ocean to ocean would be about 93½ miles. The summit of the range at the site of the tunnel is 1,180 ft. above sea level. As to harbors, the Gulf of San Miguel promises an excellent harbor on the Pacific side, but it is not so clear as to the harbor on the Atlantic side. The climate would probably compare favorably with the other parts of the Isthmus.

We now come to the Darien route, extending from Caledonia Bay or Port Escosces on the Atlantic to the Gulf of San Miguel on the Pacific. As to harbors, Caledonia Bay contains four distinct harbors, all extensive and comparatively easy of access, according to the report of Commander Selfridge, U. S. N. The climate in this neighborhood is said to be very healthful. The summit of the range is said to be not more than 260 ft. above sea-level, but Dr. Cullen thinks that it is lower, and that no locks or dams will be required, but simply a sea-level cut. Dr. Cullen states that Commander Prevost, of the steamer "Virago" of the British Navy, made an exploration up the Savanna River and ascended the range, giving the altitude as 120 ft., from which he could see the Atlantic. D. Caldwell, of the U. S. Frigate "Independence," made an exploration of this route and found an elevation of 160 ft., as nearly as it was possible to judge without measurement. In the report of Admiral Davis, U. S. N., mention is made of a road recently discovered leading from the port of Savanna to that of Caledonia, but Commander Selfridge, U. S. N., reports that he found no low summit level. As to the rivers, there do not appear to be any large ones to be crossed, while the Savanna River is proposed as a part of the route. The total distance in a direct line would be about 39 miles.

Several years ago surveys of the Darien route were made by Mr. Gisborne, an English engineer, and a company was organized to build a canal, Mr. Gisborne, Sir Francis Fox and Mr. Thomas Brassey being interested in the project. I have for some time past advocated an investigation of this Darien route, and from the inquiries and researches which I have made it seems to me that it may be found entirely feasible. It should, at any rate, be investigated by the new commission recently appointed by the President. Yours truly,

Chicago, June 10, 1899. Thomas W. Hurst.

Meetings and Excursions of Engineering Societies in London.

Sir: The American exporter is the best advertised individual of this era of newspaper enterprise. The space which is so dearly purchased by the British manufacturer is given, without stint and without price, to chronicle the triumphs of American competition in the markets of the world; to explain in detail the superiority of manufacture, the excellent features of shop practice, the wonderful organizing ability and the inventive genius, the labor-saving machinery and the time-saving devices of the exceedingly practical and enterprising nation across the Atlantic which is now confessedly pushing its commercial victories at a rate quite unparalleled in previous history. The recent awards of considerable contracts for American bridges and American locomotives over the heads of English manufacturers were telegraphed to the remotest corners of the British Empire, and it is no exaggeration to say that in every newspaper publishing ordinary news of the day reference of some kind has been made to this startling victory of American trade enterprise. Class journals have commented on the subject from every point of view; magazines have had more lengthy and weighty articles; even society proceedings show from the hard-facts-dealing-view of their learned authors the causes of the superiority of American products.

These opinions and comments speedily make their way to American newspaper columns through the media of the telegraph office, press cuttings, special correspondence and consular reports, and in the dollar-a-line space of the great city dailies the triumphs of live Yankee intelligence, capital and enterprise, are again widely advertised to an appreciative nation, which is in turn stimulated for further conquest. Truly, then, the American exporter is the pet of the newspaper fraternity; his lines have fallen in profitable places; may he duly recognize his obligations with substantial fraternity.

The present is a notable week in British engineering circles; the British Association of Water-Works Engineers held its fourth annual convention in the rooms of the Geological Society, Burlington House, on Monday and Tuesday. On Wednesday morning the members visited the East London Water-Works at Lea Bridge and Walthamstow, and in the evening the annual dinner was given at the Holborn Restaurant.

The second biennial conference of the Institution of Civil Engineers was held on Wednesday, Thursday and Friday. This conference, while it does not partake of the international character of that held in Chicago in 1893, is nevertheless made up of representatives of the profession from all parts of the empire, and thus may be called imperialistic in character. It is divided into seven sections, as follows: I., Railways; II., harbors, docks and canals; III., machinery; IV., mining and metallurgy; V., shipbuilding; VI., water-works, sewerage and gas works; and VII., applications of electricity. The annual conversazione, held on the evening of Thursday, necessitated for its uses the occupancy of the entire Institution building on Great George St. Accommodations for the meetings of the seven sections, therefore, were placed at the disposal of the Institution in the building of the Institution of Mechanical Engineers, the Surveyors' Institution and the Westminster Guildhall. The President of the Institution, Sir W. H. Preece, K.C.B., F.R.S., in his address to all the sections at the opening of the conference, referred to the necessity of a very much larger building for the Institution, although its present house was completed only four years ago. The plans for the new government buildings are based on the occupancy of the land lying between Great St. George St. and the Foreign Offices, so the present building of the Institution must be sold to the government for demolition, and the opportunity is thus afforded for rebuilding on a scale more suitable for the wants of the Institution and more commensurate in grandeur with its national importance. The President also paid a high tribute to the press in acknowledging the inability of the Institution to collect and publish the daily proceedings of each section, and he stated that they depended upon the enterprise of the press to provide them speedily with such information. At the banquet of the Water-Works Engineers on Wednesday evening even more stress was laid upon the obligations of such associations to the technical press.

The numerous sections in which the conference of the Institution of Civil Engineers met necessitated a large corps of reporters to secure even the meager abstracts given in the London daily papers of succeeding days. My personal attention was given exclusively to Water Supply and Sewage Disposal papers and discussions. On the latter subject, opinion here is growing in favor of the natural or bacteriological process, as most fully illustrated by the septic tank systems at Exeter and Yeovil, how difficult the problem of satisfactorily getting rid of the sewage sludge is may be realized by the confessions of eminent men with a score or more years of study and practical experiment as sanitary engineers for their records, that very, very much has yet to be learned, and that many theories have been proved untenable.

Dr. Kemna's paper on the "Biology of Sand Filtration," was exceedingly interesting, and was awarded unmeasured praise by many eminent experts, among whom I mention only Sir John Murray, who has won celebrity for his study of deep-sea soundings with the "Challenger" expedition, and who expressed his approbation of the "practical results," of Dr. Kemna's biological studies; and Prof. Wanklyn, who referred to the mistake which was sometimes made of confounding chemical precipitants with animal life.

In company with about 50 members of section VI., I visited on Wednesday the East London Water Company's works at Lea Bridge and Walthamstow, which lie just over the boundary line of Middlesex and Essex counties, and are therefore outside the jurisdiction of the London County Council. The total area covered by the works is very large and there was a good mile to walk along the company's canal, between the pumping and filtering station at Lea Bridge and the storage reservoirs at Walthamstow. The filtering beds are 25 in number of about one acre each; the sand is all brought by rail from some distance away, and is thoroughly washed before being placed on the filter areas; the work of washing was in progress while we were there; several beds were being cleaned, and the variety and extent of work in progress over the large domain of the company was a very striking illustration of the elements which enter into the cost of a gallon of pure and potable water. The storage reservoirs at Walthamstow are a series of small lakes, to which several well wooded islets, rising 15 to 20 ft. above the surface, give a most picturesque appearance. The point of greatest interest at Walthamstow is, however, at the outlet house, where the water is passed through a large Venturi meter and thence over a weir into the canal running to the filter beds and pumps. This meter was furnished by Mr. George Kent, inventor and manufacturer of water meters at 200 High Holborn, and an old patron of Engineering News. Mr. Geo. Robertson, manager of this establishment, is a frequent visitor to the United States in search of novelties for the English market. He has an improved device for accurately registering the water passing through the Venturi meter, and at a future time I will send you details thereof.

When one is introduced to an educated Englishman it is always a reasonable assumption concerning him that he has traveled much abroad. At the banquet of the Water-Works Engineers I soon learned that the gentleman at my right was soon to sail for New York en route to Calcutta, where he had charge of several water supply systems for the government. While getting my bearings at Lea Bridge railway station, a gentleman asked me if I had ever been there before, and learning that I had not, kindly volunteered to show me the way to the water-works offices. On my mentioning Engineering News he referred to the connection with it of the late A. M. Wellington, and I then learned that he had been engaged in railway projects in Mexico, and had been in Chili engaged on railway construction at the same time as our mutual friend, Mr. J. Foster Flagg, M. Am. Soc. C. E. The gentleman's name was Mr. Henry S. Ridings, and I found him very familiar with American affairs, as he had a son resident in Utica, N. Y. At the office of the water company he introduced me to the Chief Engineer, Mr. Wm. Booth Bryan, M. Inst. C. E., who immediately welcomed me as the representative of Engineering News, to which paper he has for years been a subscriber, and which was, he remarked, a sure indicator of steamer arrivals by its never failing promptness of delivery upon his desk. Mr. Bryan conveyed the party through the pumping houses and about the filter beds for an hour, when he had to hurry off to London to give evidence before a parliamentary committee.

The problem of keeping up the supply of water for an ever increasing population, from a drainage area whose product is being steadily lessened by the ever increasing drafts upon its limited extent is a troublesome one; the experiences of an engineer like Mr. Bryan, extending over many years, are very interesting, and his familiarity with figures, dates, quantities, capacities, processes, geology, bacteriology, politics, etc., etc., the absolutely essential requirements of a man filling his office, was very interesting indeed.

On Friday afternoon an excursion party of about 75 engineers went by steamer from Westminster Bridge landing to Barking to look at the sewage disposal works. It required 1½ hours to make the trip along the crowded Thames; we were landed on a long, low-lying steel

steamer, which proved to be one of the fleet of 30 such vessels employed by the London County Council in transporting sludge to the deep sea, 50 miles out from shore. The tank steamer was so clean and bright that no suspicion of its use would be entertained. All the same, at the moment we stepped aboard of her, there were 1,000 gross tons of London sewage sludge stored below deck; we looked at the vile mass through a well hole, and very soon after the vessel steamed away on the outgoing tide. The round trip consumes ten hours of time; the fleet conveys 30,000 tons of sludge to sea each week; it costs 4¼ pence per ton to send it to sea, against 42 pence when it was pressed into cakes and offered to the farmers, who wouldn't take it; the 4¼ pence covers cost of maintenance of plant, interest, insurance and all expenses.

The excursion party were shown over the disposal area by Mr. John E. Worth, M. Inst. C. E., the engineer in charge; Mr. W. Santo Crimp, M. Inst. C. E., well known as the author of a standard treatise on Sewage Disposal, and by the resident manager of the works.

The raw sewage to the volume of 115,000,000 gallons daily reaches the works at Barking through a large tunnel; it is treated, as it flows at the liming house, to 4 grains of lime and 1 grain of iron per gallon, making about 38 tons of lime per day; 4,000 tons of sludge are precipitated and turned onto screens, where six men at two screens work day and night in eight-hour shifts raking out the solid matter to the amount of 90 tons weekly. This is carted away by a farmer, who is paid 6 pence per load, and would be burned if the farmer "should throw up the job;" 4,000 tons of liquid sludge passes on to the pumping engines, which raise it into three tanks, each tank holding one steamer load, and discharging direct into the steamer hold, 1¼ hours being the time required to empty the tank. The sludge thus disposed of, the remaining effluent is diverted through 13 channels to the Barking Creek, some 900 ft. distant. An experimental filtration bed of one acre, composed of 6 ft. deep of coke breeze, was in operation. One million gallons were sent onto the bed in each 24 hours; the bed is six years old and has not been disturbed, except that at first it was 3 ft. deep, and 3 ft. more of coke was added; the engineer stated that the extra 3 ft. did not improve the effluent, but that 4 ft. was the maximum that should be allowed, and he considered 3 ft. as thoroughly satisfactory. This is a very important statement, and my attention was called to it by Mr. Crimp, to whom it was made.

In addition to the present flow, there will eventually be added 12,000,000 gallons daily from the West Ham district. The Crossness Works, on the Surrey side, are on the same plan as the Barking works. The literature on the subject is very voluminous. These few notes, made on the run of an hour's visit, can only accentuate a few points. To describe properly such works requires days of time.

The weather in London has been very fair for the past fortnight; it has not rained once in that time; the mercury has stood in the seventies, and there has been an unusual amount of sunshine. It is the "height of the season" and this "Queen's Weather" is most favorable for the numerous brilliant functions which are gazetted daily.

G. H. F.

London, June 10, 1899.

Work and Experiences of the 1st Battalion, 1st Regt., U. S. Vol. Engineers, in Porto Rico.

Sir: The 1st Regiment, U. S. Volunteer Engineers, was organized during the latter part of June, and the first half of July, 1898, at the rendezvous, at Peekskill, New York. On Aug. 5th it proceeded to New York Harbor, where it went aboard the transport "Chester." After four very uncomfortable days in New York Harbor, the ship sailed for Ponce, Puerto Rico, Aug. 10, 1898, arriving there Aug. 15, 1898. The protocol providing for a cessation of hostilities was signed while the regiment was at sea, so that active military operations were over when it reached Ponce. The regiment was ordered ashore, however, and began to establish a camp on the nearest available site. The first night it rained, and the camp site proved so wet that it was decided to move about a mile farther from the Playa, towards Ponce proper, where a much better site was obtained. The 1st Battalion and part of the 2d had established themselves at the new site, when there came a pouring rain, in the middle of the night, which proved that the lower portions of the new site also were too wet for comfort; the water rising as high as 6 ins. in some of the tents. The Regimental Commander and the Major of the 1st Battalion were both present, and both turned out about 1:00 a. m. in very undress uniform to survey the situation. It was decided, this time, to drain the site, which was on the banks of the Rio Portugues. The prisoners in the guard-house were turned out without delay, and work on a system of drainage trenches was begun at once.

Up to this time, the way of the transgressor in this regiment had been easy, owing to the necessity of confining him, which made it necessary to adopt a more or less secure place for a guard-house, and the result was that the prisoners were sleeping quite comfortable and dry, while their more sober comrades were roughing it in the mud. The necessity for the drainage ditches cured this little defect, however, with a vengeance.

After about twenty-four hours' hard work, a system of ditches with a main outfall through the edge of the river bank was completed. The Colonel of the Regiment, the Major of the 1st Battalion, and the other officers concerned viewed this sewerage system with great complacency, and congratulated themselves that they were secure against even a tropical downpour; but in a short time they were undeceived. The Rio Portugues, opposite this camp site, is a rather insignificant stream, about 25 ft. wide, with a channel depth rarely exceeding 3 ft.; it flows between banks about 12 ft. high, and the right bank, on which the camp was located, falls away from the edge, so that the camp was lower than the edge of the bank by three or four feet, in some places. This made the depth of the outfall ditch where it opened through the bank about six or seven feet.

The moving of the regiment was almost completed when one afternoon there was a cloud-burst in the mountains back of Ponce, and the Rio Portugues began to rise. In twenty minutes from the time the crest of the first wave passed the camp, the river was within a foot of the top of the right bank, was fully 300 ft. wide, and was running at the rate of about ten miles per hour. To avoid flooding the lower parts of the camp, the main outfall ditch had to be dammed, and this was more difficult than digging it. It looked as though the stream would come right over the bank, and it was decided to pack up the baggage, ready to move, when it was suddenly remembered that the wagon train, which had been sent back to the old camp for some forage, was on the other side of the stream, and the only bridge was at least five or six feet under water. Fortunately, the water ceased to rise at this point, and in three or four hours the Rio Portugues was once more the insignificant little stream it had been. The Major of the 1st Battalion was in charge of sanitary affairs, and had built a foot bridge across the stream, to enable the men to get to the sinks; during the flood he suffered the ignominy of seeing his bridge washed away, its last support being knocked out by a dead mule.

After this a thorough search was made for a new camp site which should be high enough to avoid all floods. One was found, west of Ponce, where the Regimental Headquarters and six companies remained until the regiment was ordered home.

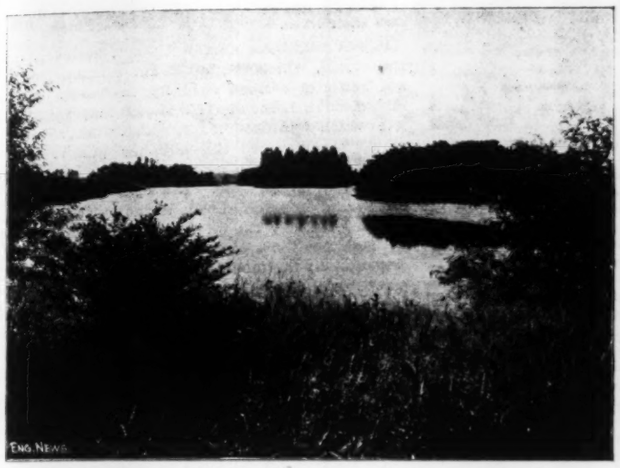
Shortly after the flood in the Portugues, the 1st Battalion was ordered to proceed to the neighborhood of Coamo, a town on the military road, about twenty miles east of Ponce, and there repair certain bridges which had been damaged or destroyed by the Spanish troops in their retreat. The battalion left Ponce Sept. 3, 1898, and arrived at its new camp, about 2½ miles west of Coamo, Sept. 4.

The bridges which had been destroyed or damaged were all on the military road from Ponce to San Juan. One, about 2¼ miles west of Coamo, was a full-center, five-ring, brick arch, of about 21 ft. span; it carried the road over a ravine about 30 ft. deep, the bottom of which was the bed of a small tributary of the Coamo River. This bridge was plastered with cement mortar, which was grooved to imitate stone masonry. It had been totally destroyed down to the springing lines of the arch.

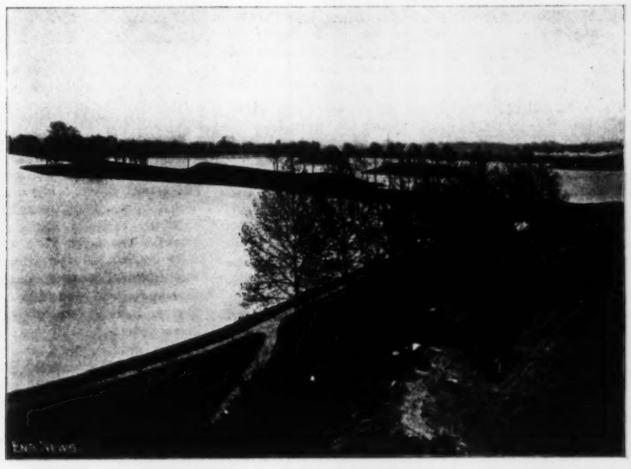
Another bridge, about three miles east of Coamo, was a segmental brick arch; an attempt had been made to blow it down, but the Spaniards were evidently in a hurry, and succeeded only in blowing a hole through the arch, which was not large enough to interrupt traffic.

About a mile and a quarter east of this bridge was a single span steel girder bridge which they had prepared for destruction by drilling the abutments; but time was evidently lacking here, also, for beyond the loss of a few coping stones, this bridge was uninjured, even in appearance, and in usefulness not at all.

Still farther on, about five miles east of Coamo, a full-center, brick arch of about 14 ft. span had been totally destroyed down to the springing lines, except a very narrow ring of badly cracked masonry which still remained in place. This last mentioned bridge was within a range of 2,500 yards of the Spanish position west of Aibonito; this position was still occupied by the Spaniards when the 1st Battalion arrived on the scene. Later on, when the Spanish troops had retired and the American outposts were advanced, it was discovered that preparations had been made for destroying a retaining wall at a point about abreast of the Spanish trenches; this would have been a more serious obstruction to our advance than any of the bridges. Near this wall, the road runs along a very steep mountain side with a slope of about 45°; where the mountain side is cut up by gullies, the road is carried straight across, being retained by masonry walls. The wall in question was one of these, and was at least 25 or 30 ft. high where it crossed the bottom of the gully; its destruction would have allowed the road



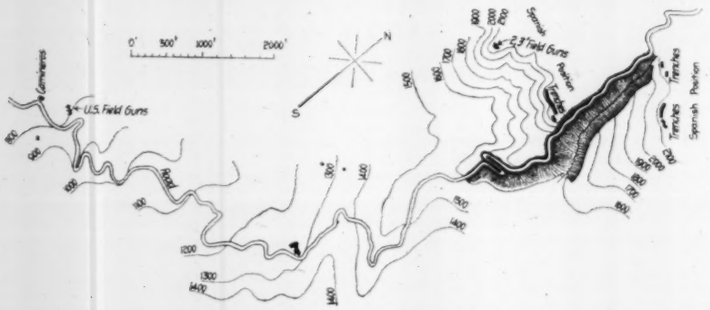
ONE OF THE OLDER RESERVOIRS AT WALTHAMSTOW.



VIEW OF "RACE-COURSE AND NO. 5 RESERVOIR," FROM TOWER OF ENGINE-HOUSE, AT WALTHAMSTOW WELL.

VIEWS ABOUT THE RESERVOIRS OF THE EAST LONDON (ENGLAND) WATER COMPANY.

to slide bodily down the mountain side to the bottom of the ravine, at least 400 ft. below. The Spanish position near Aibonito was exceedingly strong; it commanded the road for miles; a kitten could hardly have found a spot on the road where it would be invisible from the Spanish trenches. These occupied the crest of the southern escarpment of the mountains, and an idea of the ruggedness of the country may be obtained from the statement that some of our field guns engaged the enemy from a point which was only 2,000 yards away, yet nearly 500 yards below, and a wide valley intervened between the two positions. The elevation of the Spanish trenches was



MAP OF MILITARY ROAD ACROSS THE MOUNTAINS IN PORTO RICO, SHOWING SPANISH POSITIONS NEAR AIBONITO.

about 2,200 ft. above the sea. The position occupied by our guns had an elevation of 800 ft. Had it become necessary to drive the Spanish troops from this position, there would have been at least one battle in Puerto Rico that would have been long rememberd.

The orders of the 1st Battalion were to rebuild the bridges; permanent works have not generally been considered a part of military field engineering, but the volunteer engineers were recruited only from mechanics and skilled laborers, with a few young men with technical education, and the 1st Battalion contained a sufficient number of good bricklayers for the work in hand.

The principal difficulty was to obtain suitable materials on short notice; some cement, captured from the Spaniards, was obtained from Ponce. It was of rather poor quality, but was all that could be obtained, and it was made to do. Sand was obtained from the stream beds; bricks were purchased from the native brick yards; they were of very irregular shape, and very soft, but they also were the best that could be obtained. The original masonry of the bridges was of bricks not much harder than these, but of much better shape; those showing on the face of the unplastered work had evidently been rubbed down to accurate shape, especially those acting as voussoirs. The mortar in the original masonry was apparently lime mortar, with brick dust added, whether for coloring purposes or to give it hydraulic properties, could not be learned. So far as workmanship went, the original masonry was beautiful; with the material used, it could not have been excelled. The problem of the 1st Battalion was to equal it, with inferior materials; be it said to the credit of the officers and men in immediate charge, and especially the men, they executed a job so nearly equal to the original that only a trained eye would notice the difference.

In executing the repairs, it was desirable not to interrupt traffic. When the engineers arrived, the two bridges that were destroyed had been temporarily repaired with logs, brush and earth; with considerable difficulty, a quantity of spruce planks, 1½ × 10 ins., with some large nails and a few bolts, were obtained; with these, king post trusses were built, spanning the breaks in the masonry, one on each side of the roadway. After they were in position, the floor beams and a plank floor were put in, at night, over the temporary log bridge, and high enough to permit the masonry to be rebuilt under the plank floor. Suitably graded approaches of earth were prepared at each end of the king post bridges. The log roadway was then taken out, all cracked and injured masonry removed, and the arches were rebuilt on the original lines as nearly as possible. After they were finished, the king post bridges and the temporary approaches were removed at night, and the permanent roadway restored as rapidly as possible. The other damaged arch bridge, the damaged abutments of the steel bridge, and the damaged retaining wall described above, were all repaired; many minor repairs were made to parapets on bridges and retaining walls along the road, the damages being due to wear and tear, and not to the Spaniards. For the excellent work done, credit is especially due to Captains Merritt H. Smith and A. R. Livingston, both of New York city, and, among the enlisted men, to Sergeant Pearson, of Co. A, who was a most efficient foreman.

In addition to the work on the bridges and road, the battalion built frames for nearly 100 hospital tents at the field hospital near Coamo; and, after the departure of Gen. Ernst's brigade, it was charged with the maintenance of order in the Coamo district. A few shots fired at a fleeing bandit by a party sent to arrest him were the only hostile shots fired by the battalion during the war.

During the work on the bridges, it was discovered that when the men could work at night, they could do as much work as they had been accustomed to do in the United States, without serious results. But, during the day, the rate of work had to be lessened always and suspended altogether between about 11:00 a. m. and 3:00 p. m., to avoid undue exhaustion.

The bricks were generally delivered in bullock carts, 500 bricks constituting a load for four bullocks. On one occasion, when the bullocks were not available, one of the battalion baggage wagons, with two mules, was sent for bricks. The brick yard was muddy, and after 500 bricks were loaded, the proprietor stopped his men, saying it was doubtful whether the mules could pull the load. The teamster, who had driven brick wagons in the United States, insisted on having 1,000 bricks, and the proprietor yielded, after warning him that he would be stuck in the mud. The teamster, however, whistled to his mules, and they started off with the load, to the intense astonishment of all the employees of the yard, who hastened to turn out all the neighbors to see two mules pull 1,000 bricks.

On Nov. 5, the battalion was ordered back to Ponce. The order was received at 11:00 a. m., and at 4:15 p. m. the return march was begun in a pouring rain, with thirty wagon loads of baggage; the men's packs were loaded on the wagons, but they carried their arms, ammunition and accoutrements; at 1:00 a. m., after a halt of nearly two hours for supper, from 9:00 to 11:00 p. m., the battalion arrived, in good order, at the old camp on the Portugues, having made the 21 miles in about 7 hours of actual marching time, wading seven fords on the way. The men had had no practice marching, yet only two fell out on the way to Ponce, and very few cases of sore feet or stiff legs developed next day. The performance of the battalion on this march is another indication of the fact that, within the tropics all violent or prolonged physical exertions should be confined to night time, as far as possible.

The battalion returned with the regiment, arriving at New York, Nov. 24, 1898.

The military road from Ponce to San Juan is a beautiful piece of work; every gully and stream is spanned by a substantial bridge or culvert, except between Ponce and Juana Diaz; here, several bridges are much needed, but the approaches would be very long, and the structures quite expensive. A cursory examination of the arch bridges and culverts, in good weather, would lead one to think that rather elaborate preparations in the way of aprons and sills had been made to resist scour; but after seeing one of the insignificant little streamlets or a dry gully become a raging torrent within the space of ten minutes, with the water rising above the springing lines of the arches, the necessity for the aprons and sills is apparent; even as it is, the earth is scoured away from behind wing-walls and from under aprons and sills in many cases, where one would say it was impossible, but for the fact that it has occurred.

The steel bridges west of Aibonito are all lattice girders, with steel trough floors; the road metal is carried across the bridges, and the webs of the girders are solid plates, up to a point above the surface of the road. From there to the top chord, the webs are of quite light lattice work.

While the 1st Battalion was engaged upon the work described above, the remainder of the regiment was busy on works of various kinds, including a road and redoubt at Guanica, a reservoir and ice plant for the hospital at Ponce, surveys, road repairs, etc., etc., demonstrating that every kind of mechanical skill is now called for in the operations of war and those that result therefrom.

The field officers of the regiment were Col. (afterwards Brig.-Gen.) Eugene Griffin; Lieut.-Col. H. F. Hodges (Captain, Corps of Engineers, U. S. A.); the writer, commanding 1st Battalion; Major Ira Shaler, commanding 2d Battalion, and Major J. D. Ferguson, commanding 3d Battalion.

Out of a total of 375 officers and enlisted men, the 1st Battalion lost, by disease, three enlisted men while in Puerto Rico.

John Stephen Sewell,
1st Lieut., Corps of Engineers, U. S. A.
735 North Capitol St., Washington, D. C., June 13, 1899.

(Lieut. Sewell accompanies his contribution by a sketch map which we herewith reproduce, and which is of especial interest in connection with an incident of the Spanish-American war which we have seen nowhere recorded.

The late Captain Alfred E. Hunt, of Pittsburg, Pa., whose obituary notice appeared in our issue of May 11, is said to have been the only commissioned officer who went to Cuba or Porto Rico in the late war and brought back to the United States every man of his command. Those acquainted with Captain Hunt's vigorous personality and untiring industry can well understand how zealous and intelligent was his care for the health of the men in his charge, and to it many doubtless owe their lives.

It was only by a narrow chance, however, that Battery B, which Captain Hunt commanded, did not suffer a serious casualty in battle. If we mistake not, Lieut Sewell's sketch map shows the site which was occupied by Capt. Hunt's battery which accompanied the advance guard in the movement along the military road toward San Juan on Aug. 12, 1898. The Spaniards had been discovered in force ahead; an advance along the winding road by the infantry, under fire from the Spanish positions above, would have been utter destruction; the mountain side was too rough and steep for a flank movement, and it was deemed best to try and dislodge the enemy with artillery. Capt. Hunt's battery was placed in position, its guns were trained on such of the enemy's positions as could be discerned, and the gunners took the lanyards ready to fire at the word of command. At this moment a mounted orderly came tearing along the road from the rear at a break-neck pace, and as soon as he came within hailing distance he shouted the news of the final signing of the peace protocol. A flag-of-truce was at once displayed, was answered by the Spanish force, and an officer from each side galloped forward. The American was the first to reach a turn in the road from which the entire Spanish position was visible; and he then saw that the position of the American battery was absolutely commanded by the long entrenchments on the heights above, which were filled with a large force of Spaniards. Had the first shot been fired from Battery B, it would have been answered by a volley of Mauser bullets over a known and practised range, so short that the battery and its supports must inevitably have been annihilated.—Ed.)

Work of the Third Regiment U. S. Volunteer Engineers in Cuba.

Sir: The training, both military and engineering, of the Third Regiment of U. S. Volunteer Engineers, occurred in this country before its departure for Cuba.

The Third Battalion disembarked at Matanzas, Dec. 23, 1898, and had the honor of raising the American flag in that city on Jan. 1, the day marking the end of Spanish sovereignty in Cuba. Captain Sturtevant and men from his company immediately proceeded to construct a dock, 30 × 95 ft., the piles being driven to a penetration of 8 ft. by means of a hand pile-driver. The caps used were 12 ins. square, the joists were 3 × 12 ins., and the decking 2 × 12 ins. This dock was subsequently used for disembarking and embarking all U. S. troops as well as for loading and unloading all U. S. transports. Captain Hand and men from his company constructed two inclined approaches along the face of the bluff from the top of the bank to this dock, about 30 ft. below. A part of the excavation was in rock. The road was made of soft limestone, filled in with gravel and sand, and shortly wore down to a surface resembling carefully laid macadam. Among the duties of this battalion were also the location, laying out and preparing of all camp sites in the vicinity of Matanzas, including the 2d U. S. Cavalry, 160th Indiana, 3d Kentucky, 12th New York, and 8th Massachusetts Regiments of Infantry, and the Brigade Headquarters. This work comprised the cutting and burning of the brush, breaking off with sledges and leveling the projecting coral rock that everywhere protruded through the surface of the ground, preparing tent floors and flag poles

and attending to all carpenter work. Men from the battalion were overseers of the Cuban laborers (numbering at times as high as 300), under the direction of Captain Westerfield and Lieutenant Zarbell. A target range was built for the 2d U. S. Cavalry, and a second range for the general use of the Infantry Brigade, by Captain Sturtevant. Repairs were made to Fort San Severino, by Captain Sturtevant, to prepare it for occupancy by the 10th U. S. Infantry; and certain casemates were fitted for use as a general prison. This necessitated considerable brick and stone work. One-half mile of 4-in. water-pipe was laid by Lieutenant Brown, with Cuban labor; one-third the distance required blasting in rock. Two supply tanks of over 3,000 gallons capacity each were also constructed.

The repair of all old road and the construction of a new road (about two miles in length) to extend to the sand batteries at the mouth of Matanzas Bay was in charge of Captain Sturtevant, and branch roads to the different camps, aggregating about two miles in length, were constructed by different officers. A road, about two miles long, was built by Captain Hand to the 2d Cavalry camp. Considerable rock work was encountered in all of these. All heavy ordnance, including guns, carriages, shot and shell, was transported from the sand batteries on the north shore of the bay to Fort San Severino by Lieutenant Gwynn. Captain Sturtevant, or Captain Westerfield, superintended the moving of all freight (brought by government transports from Dec. 23, 1898, to April 14, 1899) from the lighters alongside the wharf to the top of the bank. Measurements and plans of Fort San Severino were made by Lieutenant Fairback; of San Cristina Barracks (now being remodeled) by Lieutenants Griffin and Fairback; of Fort Pinas Altas by Lieutenant Zarbell; and of Santa Ysabel hospital by Captain Westerfield. Construction of all sinks, plans and construction of garbage chutes into the sea, etc., for the Brigade camp were in charge of Lieutenant Dibble.

The cleaning of the streets, care of sewers and drains, and all matters relating to the sanitary condition of the city of Matanzas, were under the supervision of Captain Mattair. A map of the city was made and cesspools, cisterns, sinks, sewers and water-closets were all plotted on it by enlisted men of the battalion. An examination and survey of Cardenas, Colon and Recreo, and reports thereon, especially as to their sanitary condition, were made by Captain Westerfield; Captain Hand examined and reported upon the railways of the entire province, extending to details of roadbed, stations, water supply, equipment and bridges. The report and estimate included all the requirements to put the railways in a first-class condition for commercial and military purposes. Captain Sturtevant constructed a government dock in the city of Matanzas, to be used hereafter by bonded warehouses, etc. Over 100 piles were driven to an average penetration of 27 ft. The caps used were 12×12 ins. outside and 10×12 ins. inside; the joists were 6×12 ins., and the decking 3×12 ins. Before beginning the work the pile-driver had to be practically rebuilt. All the work, except handling the timber, was done by men of the battalion.

A military road reconnoissance of the entire province of Matanzas was made by Lieutenants Zarbell, Brown and Rhea. As a rule the main party would follow the main road, reading distances from an odometer attached to a wheel constructed for the purpose, the compass giving the direction. A party would be sent along the next parallel road to the right and another to the left (generally from three to five miles away), following similar methods except that distances were paced. Usually in eight or ten miles the parties would meet again. In this way all the roads and the important trails were traversed, and notes of military importance taken. The Batson and Cavalry sketching cases were employed. The extreme southern part of the province is swampy and without roads; canals form the only means of communication. The accurate existing maps of the railways of the province formed the framework upon which was constructed the resulting road map of the province as drawn from these reconnoissance surveys.

Lieutenant-Colonel Jadwin was in command of this battalion until illness necessitated his return to the United States, March 1; then Captain Sturtevant was in command until the arrival of Major Walke, March 15, 1899. In January, Regimental Headquarters and the Second Battalion were ordered to Cienfuegos, arriving there just as the last of the Spanish troops were sailing from the island, and going into camp on the eastern side of the city on Feb. 10. In the latter part of March the battalion moved into the Engineer Barracks in the city. Soon after arriving, Colonel Gaillard was appointed Chief Engineer of Santa Clara Province; and a work of great and immediate importance was at once taken up—a report upon all the forts, batteries and defenses of the province. Chief among these were the reports on the fortifications defending Cienfuegos accompanied by six blue-prints of plans, profiles and locations, with 15 photographs illustrating the same; and upon the fortifications defending Isabela de Sagua, Caibarien, Casilda and Tunas de Zaza with 5 blue-prints of plans, profiles and locations, and 7 photographs illustrating the same. As a suggestion of the situation investigated, it may be noted that among the defenses of Cienfuegos there were found 14 rifled guns, of more or less obsolete type, mounted and ready to be served, varying in caliber from about 4 to 8 ins., all muzzle-loaders in well constructed modern batteries. The report also contained a description of the torpedo and naval defenses of the port of Cienfuegos during the war.

Besides the many routine duties and reports, Colonel Gaillard also made a complete report upon the water supplies and the sanitary condition of Isabela de Sugua, Sagua la Grande, Caibarien, Remedios and Camajuani; a report upon the necessary improvements to Cienfuegos harbor, including lighthouse, dredging, marking by buoys and other works necessary for commerce and to enable vessels to load and unload without the use of lighters; a report upon the sources of fresh water supply around the bay of Cienfuegos for troops to be in camp at Punta Pasacaballos, etc. The maps involved in the investigations just mentioned, as well as those of the work of the battalion mentioned below, were all traced in the office of the Chief Engineer by men from the battalion, and from these 88 tracings and 263 blue-prints were made and distributed among the officials interested.

Other engineering work was diligently carried on. So earnestly was it prosecuted by officers of the Second Battalion that frequently there were only two line officers available for the military duties. The more important (omitting work on camp sites and other minor employment) include: The sanitation of Cienfuegos under Lieutenant Codd, beginning with the cleaning and improvement of the streets, then of the yards and courts, and finally of all of the latrines and cesspools. The inspectors were enlisted men of the battalion, and the work was done by the Cubans. The death-rate of the city, which was 138 for the week preceding the first distribution of rations to the starving, was reduced to 73 for the week before the sanitation was begun; and this had steadily continued decreasing, reaching 29 for the last week the battalion was in the city. A survey of the city of Cienfuegos was made by Lieutenant Shaffer, with benchmarks on every block and elevations at every street intersection.

The condition and administration of the inadequate water supply of Cienfuegos was investigated by Lieutenant Reagan. One source was the Calabazas springs, about two miles east of the city, and the other the Jicotea River, about seven miles northeast, the water being delivered through a 4-in. pipe that is 27 years old. Irregularities and abuses were stopped, and the company was forced to comply with the terms of its concession. An artesian well was bored near the city's reservoirs, under the direction of Lieutenant Murray, and this well had reached a depth of over 200 ft. at the time of departure of the battalion. Captain Smith investigated the Matagua Falls (about 20 miles southeast of Cienfuegos) and the Hanabanilla Falls (about 27 miles east of Cienfuegos), both in the mountains, as a possible source of future water supply and power for the city.

Military road reconnoissance, aggregating more than 800 miles, were made by different non-commissioned officers of the battalion. The province of Santa Clara was quite extensively covered in this way, excepting an area in the northeastern part and a small portion of the extreme northwestern part. Some of these roads were traversed under circumstances involving hasty marches to more important service or to reach supplies, resulting in incomplete notes; so that the actual mileage mapped was 443. The Batson and Cavalry sketching cases were used, distances paced and notes of military importance taken. A reconnoissance map was made by Lieutenants Black and Pasco, in complete detail, of all the region around Cienfuegos included within the line of defense enclosing the "cultivated zone." This was plotted to a scale of 4 ins. to the mile, with contour intervals of 10 ft., and covered an area of about 40 square miles. Captain Thomas reported upon the condition and administration of all the connecting railways of Santa Clara Province, amounting to a total of 277 miles. A very careful examination was made of the railway between Cienfuegos and Villa Clara, and the Sagua la Granda, and Unidos de Caibarien railways and the Hierro-Cardenas-Jucaro highway. Captain Thomas was later ordered by General Bates to proceed to Havana for a conference with the managers of the railways between Havana and Cienfuegos to obtain concert of action in securing better connections and more reliable service between these points.

To different officers and men fell the inspection, measurements, plans, and estimates of cost of improvement and repairs to barracks at Placetas, Cienfuegos and Remedios; and later the supervision of repairs to these buildings; warehouse construction; wharf repairs; bridge repairs and construction. A complete hydrographic survey of Cienfuegos Harbor was made under the immediate direction of Captain Bellinger. This work was done in the way usual for such surveys in this country; soundings were located by transit intersection and were made from the launch of the "Bay State," then lying in the harbor, and 2,600 soundings were taken. Lieutenant Thomas directed the borings, 21 in number, extending to an average depth of 30 ft. below m. l. w. These borings were made for small distances in deeper water by "churning" an iron rod into the sand and gravel. Where the borings were through a considerable depth of earth, or through clay, a 1¼-in. pipe, jointed in sections of about 5 ft., was used, the pipe being driven by a mahogany hammer worked by hand, the prolongation of the pipe upward serving as a "guide," as well as a point of attachment for the small sheaves; and by this ingenious arrangement complexity of apparatus was avoided and the blow of the hammer was advantageously delivered upon the collars of the successively coupled lengths of pipe. Samples of the earth driven through were secured from the interior of the pipe, and the method worked admirably wherever solid rock was not encountered. The shoreline and triangulation as well as tidal observations were placed under Lieutenant Shaffer's immediate charge. The tides were observed for one lunation, the average range being 0.95 ft., the maximum range for one tide 1.77 ft. and the minimum 0.29 ft. Major Van Ornum was continually in command of the Second Battalion.

The First Battalion arrived in Pinar del Rio, Feb 22, 1899, camping until April 3, when it moved into the Cuartel in Pinar del Rio. About March 4 work was commenced, under direction of Captain Averill, repairing and cleaning the Cuartel—a two-story stone building, about 250 ft. square, with an interior court about 140 ft. square. Cuban labor was employed for the coarser work; carpenter work, painting and bricklaying was done by men of the battalion. A contour map and location for barracks, stables and other buildings for infantry regiment and cavalry squadron in Pinar del Rio was made by Lieutenant Fain; also a preliminary line for water supply and sewerage for the barracks buildings was laid out.

Military road reconnoissances in the usual way were made from Esperanza through Vinales and Pinar del Rio to Coloma (across the island from north to south), a distance of about 47 miles; from Pinar del Rio to San Juan y Martinez and San Luis, about 25 miles; and from Pinar del Rio to Sumidero and Mogota de Cabezas, about 20 miles. The officers having direction of this work were Captain Fauntleroy, Lieutenant Fain and Captain Crecelius, the latter making a survey rather than a reconnoissance, as he used the transit and stadia instead of the sketching cases and pacing. Signal stations were established over a considerable area about Pinar del Rio, for triangulation in order to check road reconnoissances; but only a few angles had been taken and a base-line measured when orders to prepare to leave were received. Captain Averill was in command of this battalion during its stay in Cuba.

Early in April of this year the regiment received orders to prepare for the return to the United States. Headquarters and the Second Battalion sailed from Cienfuegos April 13, and the First and Third Battalions from Havana April 15. The regiment was mustered out of service at Fort McPherson, Ga., May 17, 1899.

J. L. Van Ornum, Assoc. M. Am. Soc. C. E.,
Late Major 3d Regt., 3d Battalion, U. S. V. Engrs.
Beers Hotel, St. Louis, Mo., May 26, 1899.

(Since the above was in type we have received from Capt. L. F. Bellinger, of the same regiment, an account of its operations in Cuba which duplicates in some particulars Major Van Ornum's. We print it, omitting these parts, below.—Ed.)

Sir: Through the efforts of Col. Eugene Griffin and others, an Act of Congress was passed and approved on May 11, 1898, which permitted the raising of three regiments of twelve companies of ninety-one men each, 1,159 officers and men to each regiment. The officers were to be selected for their skill as military, civil, mechanical, electrical or topographical engineers, and an effort was made to recruit the enlisted men from among "machinists, steam engineers, blacksmiths, carpenters, plumbers, telegraphers, topographers, draftsmen, photographers, railroad men, riggers, boatmen and those skilled in the use of explosives," also woodchoppers and laborers.

The 3d Engineers had for its Colonel Capt. D. D. Gaillard, U. S. Engineers, who accepted his commission June 16, 1898. Most of the officers were commissioned July 13, as the result of their examinations. They were at once set to work recruiting for the regiment all through the South, and by July 29, 640 men were rendezvoused at Jefferson Barracks, Mo. Eight companies were mustered in between July 26 and Aug. 4, and the last company was mustered in on Aug. 20.

The effect of having officers accustomed to handling men, and of having a high grade of men to handle, is seen in the march of six companies, in heavy marching order, 27 miles in one day, with only five men reporting with sore feet at sick call next morning; also in the response to a midnight call to arms, in which the regiment was formed and on the march, with 20,000 rounds of ammunition issued, all within 23 minutes from the time "first call" was sounded.

In the United States, engineering drill and instruction were pushed forward until the 3d Battalion left for Cuba, disembarking at Matanzas, Dec. 23, 1898, and raised the American flag on New Year's Day, denoting the end of Spanish rule in Cuba. * * * * * * *

The battalion at Cienfuegos turned out on Feb. 13 to receive Gen. Gomez and his "Triumphal Army". (?) of 150 men; also on March 30, to be reviewed by the Secretary of War.

The special difficulties encountered were, the proximity to the surface of the coral limestone in Matanzas Prov-

ince in locating sanitary camp sites, the malarious swamps encountered in mapping Matanzas Province, the impure water which, to fit it for drinking, was all boiled (at Cienfuegos, the only good unboiled water was brought in by train 80 miles), and the enmity of the inhabitants, necessitating all survey parties to be accompanied by armed guards. Apparently, most Cubans hate all things American except American food and American money.

During one fortnightly period, 128 men had been checked as having been at work on the streets some of that time, yet the blandness and innocence with which about 400 workmen appeared for pay, vouched for on foremen's books as having worked all the time, would do credit to old times on the Albany Capitol, or to the Cuban veterans (?) now appearing for pay, but not appearing on their muster roll.

Of great importance is the survey of Cienfuegos Harbor. This harbor is about ten miles long by three miles wide, with a deep entrance 400 yds. wide and one mile long, with a sharp turn. At present, the largest vessels can approach within 2,000 ft. of the pier heads. The tonnage of the port last year (a dull year, necessarily) amounted to over 100,000 tons, with lighterage from 40 cts. to 80 cts. per ton. From the survey made, it was estimated that a 25-ft. channel, 500 ft. wide, with side slopes 4 on 1, an allowance of 1 ft. for "back fill," and with a "flare" to 1,200 ft. wide near the pier heads, can be dredged in mud, sand, clay and gravel, with an excavation of only 273,000 cu. yds. About as much more should be dredged out of the slips, and all dredged material could be used to fill in low land about ½ mile from the excavation, and the harbor is a clean one in which to dredge. It will be seen that the cost of lighterage for one year will about pay for deepening the ship channel to 25 ft.

This work, enumerated above, was done by the regiment in less than three months, in addition to guard duty and the regular military duty required of infantry. One-third of the men get the same pay as infantry; one-half get about 30% higher pay, and the officers get the same pay as mounted officers. All are subject to emergency calls, as previously mentioned. The value of engineer soldiers to the government is easily seen.

Very respectfully,

Lyle F. Bellinger,
Late Capt. 3d U. S. V. Engrs

Fort McPherson, Ga., June 2, 1899.

THE ALTERATION OF THE INTERIOR OF THE GRAND CENTRAL STATION, NEW YORK CITY.

The railway lines which terminate at the Grand Central station in New York city have long had before them the difficult problem of remodeling that antique structure to better suit the demands of traffic. As many of our readers know, the three railways which center there have for years had three separate passenger waiting rooms, each of them crowded, poorly lighted and inconveniently arranged. Two of these were located on the side of the main train shed, necessitating the use of portable bridges for crossing the tracks to reach the trains. A smaller train shed on the east side has accommodated most of the arriving trains.

A year or more ago several stories were added to the part of the building which is used for the offices of the railway companies; but the first floor with the passenger waiting rooms was left untouched. Although plans were made for the reconstruction, and were described in our issue of June 6, 1898, they were not carried out.

Now, however, it has been determined to proceed with this work, and plans for it have been prepared by Mr. Samuel Huckel, Jr., of the firm of Hazelworth & Huckel, Philadelphia, Pa., in consultation with Mr. W. J. Wilgus, Chief Engineer of the New York Central Ry.

The main passenger entrances will be removed to the 42d St. side, which will be made the main front of the building. One exception to this will occur on Vanderbilt Ave., near 42d St., where a large general entrance will be made. As at present, trains will arrive on the east side of the train shed and depart on the west. Connecting all the track platforms, both incoming and outgoing, and extending the full width of the building, parallel to 42d St., will be a platform 30 ft. wide. On the east or arriving side this platform opens into a large covered section, which has a main exit 40 ft. wide opening onto 42d St. In this section will be a covered cab stand, 37 × 86 ft. in area. There will also be an incoming waiting room. On the second floor, directly over this platform, will be a restaurant, 37 × 60 ft., and the usual railway lunch room, with a marble counter 100 ft. long.

That portion of the station devoted to outgoing traffic naturally occupies the most space, and will attract the most attention. The passenger will enter from 42d St., through a spacious lobby, into the large waiting room, 180 ft. long, 90 ft. wide and 35 ft. high. The roof of this room will be formed by a series of arched glass panels sprung between girders, resting upon massive piers. Between these piers will be ornamental arches, and over the crown of each arch will appear the name of some important city reached by the railways which use the station. Heavy ornamental friezes and cornices will further lend to the dignity and impressiveness of this rotunda. Glass panels and partitions will insure a full and even distribution of light during the day, while at night clusters of electric lights in the ceilings and around the cornices will afford the desired light and add to the attractiveness of the room.

The lower portion of the rotunda and the lobbies will be finished in different kinds of marble, while the pilasters, cornices and other decorations will be in plaster.

At each side of the main entrance will be the ticket offices with a total of 15 windows, some of which will be for women only. At the left of the 42d St. entrance and adjoining the Vanderbilt Ave. lobby will be a women's waiting room. Opening off from this will be a toilet room and a tea room, the latter in charge of maids, and designed especially as a place where women coming to the city on shopping excursions can rest and obtain light refreshments. On this side will also be the telegraph office and telephone booths. On the right, ranged around the wall, will be the news stand, men's room, toilet, parcel and information offices.

The series of disconnected rooms along the west side of the long train shed, at present used as waiting rooms, will be thrown into one long room, which will be used as the outgoing baggage room.

All incoming baggage will be handled in a like manner on the east side, where the entire length of the train shed, about 650 ft., will be utilized for this purpose. To further facilitate the handling of baggage a subway, 18½ ft. wide and 9½ ft. high, will extend across the north end of the train shed just under the tracks. This subway will connect the baggage rooms on the two sides with six baggage elevators at the north ends of the departing platforms.

It is expected that the entire work will be completed before the close of this year.

ANNUAL CONVENTION OF THE AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.

The thirty-second annual convention of the American Railway Master Mechanics' Association was held at Old Point Comfort, Va., on June 19 to 21, 1899. After the opening prayer an address was delivered by the Hon. Joseph Bryan, President of the Richmond Locomotive Works. Mr. Bryan spoke at some length upon the history and development of the locomotive, and referred more particularly to the vast progress made during the year just passed in introducing American built locomotives into foreign countries. After a brief and appropriate address of thanks had been made by Mr. W. S. Morris for the courtesy of Mr. Bryan in addressing the convention, the regular programme of convention work was taken up. The first business was the address of the President, Mr. Robert Quayle. The Secretary's report showed the financial standing of the Association to be good. The total receipts for the year were $3,971, and the total expenditures were $3,096, leaving a balance on hand of $902, which, added to the balance already in the treasury, makes the total cash balance of the Association $3,116. The dues for the ensuing year were made $5, as in the past. The Association now has 633 members.

Following these reports the question of taking some action to limit, if possible, the time of meeting of the Master Car Builders' and Master Mechanics' conventions to one week, was taken up. Following the precedent established by the M. C. B. Association at its meeting last week, it was moved that the Executive Committee be given power to act with the Executive Committee of the M. C. B. Association to arrange for the meeting of the M. C. B. convention on the first three days of the week and of the Master Mechanics' convention on the last three days of the same week. After some further routine business the convention took up the discussion of topical questions. Such of this discussion as is of most general interest is given under the heading of Noon Hour Discussions, at the end of this report of the proceedings.

A Research Laboratory

The committee on this subject considered that there was need of more concerted action on the part of railways in the development of those practical and scientific facts which are useful in direct practice in the design and maintenance of railway equipment, and it urged that the Executive Committee of the Association be directed to consider and formulate a plan for establishing and financing a research laboratory. The committee itself, however, proposed the plan of using existing laboratories rather than the establishment, at least immediately, of a new plant. By selecting one laboratory for one line of investigation and another for a second line the co-operation of men and materials best suited to the needs of the Association could be secured. The cost to the Association of organizing a research laboratory on this plan was estimated by the committee at about $40,000 for three years.

Discussion.—Mr. R. P. C. Sanderson (Norfolk & Western) objected to the establishment on the basis that it would be nearly impossible to secure the necessary specialists to make its work of most value, and because he believed that individual interest and ambition would get better results in the end from the members than could be got from such a laboratory. Mr. F. A. Delano (C., B & Q.) and Mr. Angus Sinclair also spoke in opposition. These negative opinions were, however, attacked by Mr. J. N. Barr (C., M. & St. P.), who urged that while the time might not be ripe for a research laboratory under the control of the Association, yet such an institution should be encouraged in the minds of railway men. It was finally moved that the recommendations of the committee be referred to the Executive Committee for further action. This closed the work of the first day's session. The remainder of the report we postpone to our next issue.

ANNUAL CONVENTION OF THE MASTER CAR BUILDERS' ASSOCIATION AT OLD POINT COMFORT, VA.

The 33d annual convention of the American Railway Master Car Builders' Association was held at the Hotel Chamberlain, Old Point Comfort, Va., June 14 to 16, inclusive. About the usual number of members and guests were present; the display of railway appliances made by the various railway supply houses was somewhat greater than in years past, and the usual elaborate programme of entertainment was carried out by the Supply Men's Association. Judged by these externals the convention can certainly be classed as highly successful, and it is gratifying to be able, on the whole, to say that the work of the convention proper fulfilled all expectations. The programme was a long one, comprising ten subjects for topical discussion and the special committee reports, besides the reports of the six standing committees of the association. As was natural to expect, some of these reports failed to develop the full possibilities of their subjects, but, generally speaking, the really important subjects were in good hands and were well handled in the reports and fully discussed by the members. To a certain extent the meetings were marred by the noise outside the convention-room, and both the business meetings and the pleasure excursions were rendered uncomfortable by the excessive heat.

Wednesday's Session.

The opening session on Wednesday morning was begun with prayer by the Rev. J. J. Gavatt, of Richmond, Va. An address of welcome by ex-Governor Charles T. O'Ferrell, of Virginia, followed. With these preliminaries finished, the regular business of the convention was begun. In his official address the President of the Association, Mr. C. A. Schroyer (Chic. & No'w'n), reviewed briefly the work of the association in the past and urged the full consideration of the various reports to be presented at the sessions which were to follow. He called special attention to the criticisms which have recently been made of the M. C. B. coupler and thought that most of the difficulties complained of could be attributed directly to the great variety of makes that were now on the market, to the inferior quality of material that was being used in their construction, and to the difficulty of handling them in connection with the link and pin couplers at present also in use. Another thing which he considered merited especial attention was the question of representation in the association. In regard to this he said:

> The question of representation in this association has been called to my attention by one of the members, and I am led to believe that many are of the opinion that representation should be changed from its present wheelage basis, where eight wheels represent a car, to a tonnage basis, as the claim is now made that railways represented heretofore having a large number of four-wheeled cars of 8,000 or 10,000 lbs. capacity, are having these replaced by eight-wheel cars having 60, 80 and 100,000 lbs. capacity. The result is that their tonnage is very largely increased while their representation in this association is very materially decreased. These conditions prevail on most of the roads in this country. The question presents a field of inquiry that merits your attention and is presented to you as food for thought, as I have no recommendation to make in this direction.

The address by the President was followed by the report of the Secretary, which showed the present membership to be 458 members, representing 1,348,131 cars. Despite the reduced annual dues of $4 the report showed a balance of receipts over expenses for the year of $454, which, added to the money in the treasury, made the total sum invested to the credit of the association $8,893. It was voted that the annual dues should be continued at $4 for the ensuing year. The hour of noon having arrived with the completion of these business reports,

and it being provided in the by-laws of the association that the noon hour of each session shall be given up to topical discussions of special subjects, this part of the programme was at once taken up. Such of these discussions as are of most general interest are abstracted under a separate heading elsewhere in this report of the convention proceedings.

Following the topical discussions the convention proceeded to the consideration of the reports of the various standing committees. The first report in order was that of the Committee on Supervision of Standards and Recommended Practice. This report suggested several minor alterations in certain standards which were in part adopted by the convention and in part ordered to be submitted to letter ballot. The next report on Triple Valve Tests proved to be of a more interesting character. Mr. G. W. Rhodes (B. & M. R.), the chairman of the committee, stated for the committee that the brake-testing apparatus owned by the association had during the year been transferred from Altoona, Pa., to the laboratories of Purdue University and had been ready for operation in its new home since Dec. 1, 1898. The committee, however, had not made any tests of triple valves.

Mr. J. N. Barr (C., M. & St. P.) expressed himself as dissatisfied with the report and asked for an explanation of the failure of the committee to test any triple valves. He said, in part:

I have learned recently that there is a strong interest urging the adoption of the New York air brake in various quarters. I believe it is true. Unless each company is to test these brakes for themselves, I think this association ought to stand in the breach and relieve individual members of that labor and expense. I think we all recognize that we cannot afford to put any apparatus under our cars that will not work with what we have, and we ought to know definitely whether it will work and how closely it will work. We have about 70% of our cars equipped with the Westinghouse air brake. The New York Air Brake Co. offers their brake for less money, and if it is as good as the Westinghouse we want it, and there are many other roads in that position. We do want information on the subject, and if the association will give it to us we are willing to wait for awhile. I would like to know, however, with the New York air brake as prominent as it has been for the last two years, why no attempt has been made to get a test of it.

In reply to Mr. Barr's remarks Mr. Rhodes made the following explanation:

At the annual convention of 1898 the following motion was offered by Mr. A. E. Mitchell: "I therefore make a motion that the standing committee on triple valve tests this year obtain triple valves from the manufacturers and make tests of them and report the results of its tests to this convention next year, giving specific names and referring to catalogue numbers." The motion was adopted, and the committee put itself in communication with the manufacturers of the New York air brake and endeavored to obtain triple valves from them for test. The President of the New York Air Brake Co. wrote back to the chairman of the triple valve committee, saying that they would not furnish any triples for test. The reasons given were two, the principal reason being that owing to an opinion given by the late Mr. Massey, in 1898, following a conversation with the chairman of the committee, they objected to one of the requirements in test No. 2. The requirement reads as follows: "The final maximum pressure in this test must not be less than 15% nor more than 20% above the pressure given by the same brake in full service application." Mr. Massey, in a communication to me, told me that the New York air brake would not meet that requirement, and he wished the committee to consider a modification of these rules. He acknowledged that it was a good feature in a triple valve, but did not consider it was a vital or essential feature, and wished the committee to change it. On that score the New York Air Brake Co. objected to submitting their triples for test. They made the further argument that they had a large number of triples in use, but that the present composition of the committee on triple valve tests was such that no member of the committee had had any experience in the use of their triples, and that they did not think their triples would get the attention or the care that they would if some of the members knew more about the advantages of this triple valve. I thought that both these points were legitimate objections and were points that this association should give some attention to. The recommendations for the tests were made in 1893, when we were pretty fresh from a large number of practical road tests, both at Burlington and subsequently on the New York Central road, and it would look to me to be quite reasonable that if there is any number of interests involved which would like to have these rules gone over and reinvestigated this association should consent to that and perhaps recommend it. It is true that at the time that this matter was brought up that the committee then had no experience with the present New York triple, and I see no objection at all (I think it is rather a desirable thing) that there should be one or two members on the committee who have had experience with and know the service given by the New York triple. There is an abundance of them in service now.

Following Mr. Rhodes' remarks, Mr. Barr made a motion that two members familiar with the practical working of the New York air brake should be added to the present committee, which was carried by a vote of the convention. A second motion was then presented by Mr. Barr, specially empowering the committee to test triple valves and to expend from the funds of the association any money necessary to conduct these tests up to a total of $5,000. This motion was carried after some discussion.

Thursday's Session.

The greater part of the second day's session of the convention was devoted to the revision of the rules of interchange. A number of minor changes were made, and, as is usual, a greater number of suggested changes were threshed over in discussion and finally rejected. Some general interest is attached to one or two of the changes made, but for the most part they do not claim attention outside of those directly concerned in the operation of the rules in practice. The prices for M. C. B. couplers were altered to provide the charging of 4½ cts. per lb. for coupler parts of steel couplers outside of body or shank, for which the present price of $4.50 was continued. This change made the new price of steel couplers complete $7.50, or $1 more than the price last year. In the passenger car rules a new section was added, as noted further on in the report upon Pintsch Gas in Interchange.

The reading of the reports of special committees followed. The first report taken up was that of the committee on prices west of the 105th meridian.

Compensation for Car Repairs Done West of the 105th Meridian.

For some years the members of the association, who represent railways which are located west of the 105th meridian, have been complaining that the prices for car repairs stipulated by the M. C. B. Rules of Interchange were very much lower than the actual cost of such repairs to them because of the much higher cost of labor and material in the far West than in the East, and have asked that they be allowed to add enough to the established prices to compensate them for the difference. The various arguments presented for and against this change in the rules have been given more or less in detail in the reports of previous conventions which have been published by Engineering News and they will not be gone over again here. It is enough to say that the report of the committee recommended that no change be made.

Discussion.—Contrary to what might have been expected, the discussion upon this report was quite short. Briefly stated, the representation of the Western roads which have been making the fight for the proposed alterations contented themselves with making a protest against the conclusion reached in the report.

The next report was that of the standing committee upon Wheel and Track Gages. The chairman of this committee, Mr. J. N. Barr (C., M. & St. P.), stated that his conferences with the American Railway Association indicated that the present dimensions were satisfactory and that there was no occasion for any change. The committee was discharged by vote of the convention.

The next report was that of the committee upon Brake-Shoe Tests. This committee recommended that it be instructed to test such new shoes as had been put upon the market since the original tests were made. This recommendation was concurred in by vote of the convention. The next report was that of the special committee on trains parting.

Trains Parting.

The time-honored custom of depending upon a circular letter of inquiry to secure the necessary information upon which to base conclusions and devise a remedy for the fault being investigated, failed here, as is so often the case, to accomplish the result sought after. Upon the information received, however, the committee based the following conclusions:

Spindles should be maintained at not less than 2 ins. in diameter and keys at not less than ½ x 2 ins. More care should be exercised in making the pockets, to avoid sharp corners on the rear end. In car inspection a close inspection should be made of knuckles and locks, in order to reduce unnecessary play. It is necessary to make a systematic inspection of couplers in service, with the view of limiting the variation from the M. C. B. contour lines, using a special gage for the purpose. M. C. B. buffer blocks are recommended on all cars, to relieve the shock to draft rigging in slacking up.

The committee stated that only one form of gage was submitted for its consideration, a diagram of which is shown in Fig. 1. In this connection it will be interesting

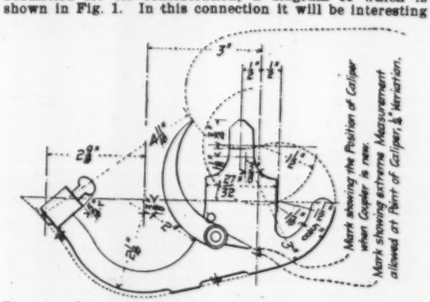

3"
2 1/4"
4 1/2"
2 3/8"
1 1/4"
Mark showing the Position of Caliper when Coupler is new.
Mark showing extreme Measurement allowed at Point of Caliper, 1/2" Variation.

Fig. 1.—Gage for Determining Permissible Amount of Wear in M. C. B. Couplers.

to study the form of gage recommended by the committee report on M. C. B. couplers reprinted separately elsewhere in this issue.

This report was not discussed and with its presentation the convention adjourned its session.

Friday's Session.

At the opening of its third and last session, the convention found before it a lengthy programme of unfinished business upon which it set energetically to work. The consideration of the remaining special committee reports first received attention.

Square Bolt Heads and Nuts.

The interest of this report lay in the special tests conducted at the laboratories of Purdue University for the committee, to determine whether the smaller size of bolt head recommended by the manufacturers was as strong as the standard size head adopted by the Association some years ago. The tests were made under the direction of Professors W. F. M. Goss and W. Kendrick Hatt.

The position had been taken by the manufacturers that the large head called for in the U. S. standard involved the upsetting of so large a mass of metal that two blows were necessary to perform the work. Consequently, the proper degree of heat could not be maintained during the operation and the resulting bolt head was thus weaker than would be the smaller head, known as the manufacturers' standard head. The tests, which were very elaborate and were reported by Professor Hatt in much detail, showed that the smaller heads were the stronger. The committee presented Professor Hatt's report with the following as its own final conclusions:

It will be seen from Professor Hatt's report that there is evidently ample strength in the smaller heads, and that as far as the question of strength is concerned, there is no reason why a smaller head than the M. C. B. or M. M. standard cannot be used, and we recommend the following standard for square bolt heads:

The short diameter of head shall be one and one-half times the diameter of the bolt, and the thickness of head shall be one-half the short diameter of the head.

As regards square nuts, we recommend that no change in the present standard be made, as it is believed that there is no demand for it, and the replies from the different roads show that there is no difficulty in getting them of M. C. B. standard.

While it is true that there may be some disadvantages in having bolt heads and nuts of different size on account of difficulty in using wrenches, it is believed that wrenches can easily be made in S-form, fitted at one end for the nut and at the opposite end for the bolt head. It is also believed that it is not safe to make the short diameter of the nuts any less, as this would result in greater liability of the nut splitting.

The next, and, on the whole, probably the most important report presented to the convention, was that of the Committee on M. C. B. Couplers. An abstract of this report is given elsewhere in this issue. The discussion of the report was brief and businesslike. The recommendations concerning length of guard arm, vertical dimension of knuckles, vertical dimension of end of guard arm, vertical height of horn, trueness of axes, corners of yoke, play of shank, dimensions of pivot pins, were ordered to be submitted to letter ballot as standards. The recommendations respecting twist gages, worn coupler gage, and specifications were ordered to be submitted to letter ballot as recommended practice. The recommendation regarding the gage for new knuckles was indorsed by vote of the convention, and that regarding new dimensions for coupler shanks was referred back to the committee upon M. C. B. couplers, with a request to make the needed recommendations. The report proper was dismissed with the action last taken, and the convention took up the question of appointing a standing committee on M. C. B. couplers. Mr. A. M. Waitt (N. Y. C. & H. R.) said:

In line with the suggestion made by this committee I move that the association appoint a committee on coupler tests, to consist of not less than five members, to whom shall be submitted from time to time the testing of couplers, the committee to certify to the association those couplers that have satisfactorily passed the requirements of the standards of the association and the recommended tests. Furthermore, that this committee be authorized to arrange for construction of standard machinery for testing couplers, the same to be paid for by the association. In connection with the motion I would say that I think this subject of couplers, as well as that of brake shoes and triple valves, is of enough importance to warrant a standing committee, and having such a standing committee we should furnish them with the necessary authority and facilities for carrying out their work, so that we may have a permanent benefit from it. The railways of the country want to know what couplers can be safely used. The tendency is to introduce devices which are cheap, and we are likely to establish quite a number of additional requirements in connection with the standard coupler, and we are likely to introduce this recommended practice for tests and specifications. It is not possible for many of the railway companies represented in the association to carry on and make investigations and tests in the same way that the larger companies can, and we want to distribute the benefit of this association to all roads represented. By appointing this committee and having them make tests of couplers submitted to them, we can ask the manufacturers of couplers if they have had their coupler tested and passed. We will be informed of those which have passed and of those which have not passed, and we would be justified in refusing to use couplers that did not pass the tests. In that way the number of different couplers will be reduced.

Mr. Waitt's motion was carried by vote of the convention.

Mr. John Hickey (R. G. W.) then made a motion that the standing committee be requested "to look over the situation of all automatic couplers—any that may differ in constructive principles from the M. C. B. couplers—and report its findings to the association one year hence." This motion was opposed by Mr. A. M. Waitt (N.Y.C. & H.R.) and by Mr. R. P. C. Sanderson (N. & W.), and when put to the vote of the convention was lost.

The next report was that of the committee on "Air-Brake Appliances." A number of recommendations were made by the committee, which were ordered to be submitted to letter ballot, as recommended practice. It was also voted to continue the present committee with instructions to confer with air-brake manufacturers in relation to the adoption of their (the air-brake companies) recommended

practice, with such modifications as may be considered advisable.

Specifications for Wheels and Axles for 60,000-lb., 80,000-lb. and 100,000-lb. Cars.

In respect to wheels the committee recommended that the specifications submitted by the Committee Report of 1897 be adopted, with the following changes:

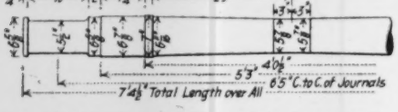
To include only 33-in. wheels, because this diameter has become universal for cars of the capacities named.

For drop tests where the wheel is struck centrally on the hub it is recommended that the wheel must stand ten blows, instead of five, of a 140-lb. weight falling 12 ft.

For the drop test where the wheel is struck on the plate close to the rim your committee has added wheels of 625 lbs. and 650 lbs.

The thermal test is made compulsory with either the drop test on hub or drop test on plate.

At the convention of 1898, Mr. E. D. Nelson, under the head of topical discussions, presented full specifications for an axle designed by him for a car of 100,000-lbs. capacity, and suggested the advisability of its adoption as recommended practice. As the result of the discussion which followed, a committee was appointed to investigate the whole subject, and to present a report. Mr. Nelson was made chairman of this committee, and the report recommended the axle which had been advocated in Mr. Nelson's paper of the previous year. This axle is shown by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